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ELEMENTS

OF THE

ANATOMY

OF THE

HUMAN BODY

IN ITS SOUND STATE;

WITH

OCCASIONAL REMARKS ON PHYSIOLOGY, PATHOLOGY, AND SURGERY.

BY

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TO

SIR ANDREW HALLIDAY, M. D.

PHYSICIAN IN ORDINARY TO THEIR ROYAL HIGHNESSES

THE DUKE AND DUCHESS OF CLARENCE,

F. R. S. E., *&c. &c. &c.*

ONE OF THE FAVOURITE PUPILS OF MY FATHER,

AND

MY MUCH ESTEEMED FRIEND,

THIS VOLUME

IS RESPECTFULLY DEDICATED.

ANALYTICAL TABLE OF CONTENTS

OF

VOLUME FIRST.

Preface, - - - xxiii

PART I.

CHAP. I

Page

General Observations on the component parts of the Bodies of Animals, - - 1
Of the Solids of the Animal Frame, - 3
On the different Tissues, - - 6

CHAP. II.

Of the Skeleton, - - 10
Of its Proportions, - - - 13
— the Purposes to which the Skeleton is subservient, 16

CHAP. III.

Of the Bones of the Adult, - - 21
Of the Form, Size, Situation and Processes of the Bones, 22
— the Chemical Analysis of the Bones, by PEPYS, HATCHET, and DAVY, in their Sound and Morbid State, 25
— the Periosteum and its uses, - 31
— the Intimate Structure of Bones, - 33
— the Marrow, - - 36
— the Nerves of Bones, - - 38
— the Bloodvessels of Bones, - 39
— the Lymphatics of Bones, - - ib.

CHAP. IV.

Page
Of the Articulations, - - 40

CHAP. V.

Of Fœtal Bones, - - 44
Of the Formation of Bone, - - 46
Experiments on the Formation of bone, by MACDONALD, Sir A. COOPER, Mr HOWSHIP, DU HAMEL, Dr MONRO *secundus*, and Mr HUNTER, - - 47–52
Authors on the Bones of the Adult, - 55
Authors on National Peculiarities of the Bones,—On the Formation of Bone,—On the Distinctions between the Male and Female Skeletons, - - 56

CHAP. VI.

Of the Bones of the Trunk, - 56
Of the Bones of the Chest, - 57
— the Moveable or True Vertebræ, - 58
— the Vertebral Canal, - - ib.
Causes of Deformity of the Spine, - 61
Of the Method of Treating deformity of the Spine, 63
— the True Vertebræ, - - 65
— the Cervical Vertebræ, - - 65
— the Peculiarities of the Cervical Vertebræ, -
First Vertebra or Atlas, - - 67
Of Fracture of the Atlas, - - 68
Second Vertebra, or Vertebra dentata, - 69
Of the Movements of the Head, 70
Dorsal Vertebræ, - - 71
Lumbar Vertebræ, - - 73
On Luxation and Fracture of the Vertebræ, - 75
Of Imperfection as to the Formation of the Spine, 76
— a Nondescript kind of Malconformation of the Spine, 77

CHAP. VII.

Of the Immoveable Portion of the Vertebral Column, 78

Page
Of the Pelvis, - - - ib.
— the Axis of the Pelvis, - - 80
Measurement of a well formed Male Pelvis of Persons of different Nations, - - 82
Measurement of Deformed Female Pelvis, - ib.
Of the Distortion of the Female Pelvis, - 85
— Sigault's operation, - - 87
— Distortion of the Male Pelvis, - 89
Of the Particular Bones of the Pelvis.
Of the Os Sacrum, - - 90
Os Coccygis, - - 92
Ossa Innominata, - - 94
Os Ilium, - - ib.
Os Ischium, - - 97
Os Pubis, - - 99
Whether the Bones of the Pelvis yield during Delivery, 102
Of the Pelvis of the Fœtus, - 104
— the Deficiency at the fore part of the Pelvis, 105

CHAP. VIII.

Of the Thorax, causes of its Form, - 106
Of the Peculiarities of the Ribs, - 160
— Effusion of Air into the Chest, - 114
— the Paracentesis of the Chest, - ib.
— the Sternum, - - 115

CHAP. IX.

Of the Skull, - - 119
Of its form, Observations on, by Dr Holland, - 120
— the position of the Human Head, compared with that of Quadrupeds, - - 121
Of the Distinctions of the Form of the Skull, - 122
— the Surfaces and Sutures, - 126
Os Frontis, - - 128
Of the Frontal Sinuses, their size, - 133
Ossa Parietalia, - - 136
Observations of Dr Monro *primus*, respecting the communication between the vessels on the outer and on the inner side of the Skull, - - 137
Ossa Temporum, - - 139

Page
Os Occipitis, - - 144
Os Ethmoides, - - 149
Os Sphenoides, - - 152

CHAP. X.

Of the Bones of the Face,—on CAMPER's facial Angle, 158
Ossa Nasi, - - 160
Of Artificial compression of the Nose by some Nations, 161
Ossa Unguis, - - 162
Ossa Malarum, - - 163
Ossa Maxillaria superiora, - 165
Of the Intermaxillary Bone of some Mammalia, - 170
Ossa Palati, - - 170
Ossa Turbinata, - - 174
Observations of ALBINUS on the connection of the Ossa turbinata to the Membrane of the Nose, - ib.
Vomer, - - 175
Lower Jaw, - - 176
Of Fractures of the Lower Jaw, - 178
Observations of Sir A. COOPER on Dislocation of the Lower Jaw, - -

CHAP. XI.

Of the Causes which determine the Size and Form of the Skull, and of those causes which determine its Shape, 182
Table of mean Diameters of Heads, - 183
SŒMMERING's Measurements of the Fœtal Skull, - ib.

CHAP. XII.

Of the distinctions in the Skull of the Male and Female, and of the distinctions of the Skulls of different Nations, - - - 196
Of the distinctions between the Skull of the Male and Female, - - ib.
— the distinctions in the Form of the Skull of different Nations, - - 197
— the Methods of DAUBENTON, CAMPER, BLUMENBACH, and others, for determining the distinctions of Skulls, 198
Table of Measurements of Skulls, by Dr LEACH, - 203
Of the First Class, or Caucasian, - 205

Page

Of the Second, or Ethiopian Class, - 209
Dr KNOX's observations in Skulls of the Nations of Southern Africa, - - 21
Ethiopian Variety, - - 211
Mongol Variety, - - 212
Tabular View of various Measuremenss of Crania, in the Museum of Dr MONRO, - 213
Of the Third or Mongolian Class, - 214
Mr EDWARD's Description of the Esquimaux, - 216
Of the Fourth, or American Class, - 218
Dr RICHARDSON's remarks on North American Indians, 219
Dr JAMES's observations on skulls of different Indians, 220
Observations on Heads of Natives of South America by HUMBOLDT, Prince MAXIMILIAN, and the Author, 223
Of the Fifth, or Malay Class, - 224
Observations on Skulls of Natives of New Holland, of Van Dieman's Land, and New Zealand, by CRUISE, 227

General Observations on the Extremities, - 234
Proportions by VITRUVIUS. - 234
Observations on these, by ARISTOTLE, - 235
Of the Bones of the Superior Extremities, - 237
— the Clavicle, - - 238
— the Os Humeri, - - 240
Observations on the state of the Ligaments in cases of Dislocations, by Dr MONRO *secundus*, - 247
Subluxation, observations on, by Mr BRYCE, and Sir A. COOPER, - - 247
Of the Fore Arm, - - 250
— the Ulna, - - ib.
— the Radius, - - 252
— the Bones of the Hand, - 255
— the Inferior Extremities, - 265
— the Thigh-Bone, - ib.
Observations on Fractures and Dislocations of the Neck, and of the Thigh-Bone, by Sir A. COOPER, Dr KNOX, Professor COLLES, and the Author, - 271
Of the Leg, National Peculiarities, - 275
— the Tibia, - - ib.
— the Fibula, - - 278
DUPUYTREN's observations on Fracture of the Fibula, 280
Of the Rotula or Patella, - 281

Page.
On Fracture of the Patella, by the Author, - 282
Of the Movements of the Knee, - 283
— the Bones of the Feet, - 285
Observations on Dislocations of the Bones of Hands and feet, - - 294
Of the Sesamoid Bones, - 295

PART II.

CHAP. I.

OF CARTILAGE.

SECT. I.

General Observations on Cartilage, - 301
Chemical Analysis of Cartilage, by Dr DAVY, 302
Of the Articular, or Obducent Cartilages, - 304
— the Interarticular Cartilages, - 305
— the Connecting Cartilages, - ib.
Observations on the Intervertebral Cartilages, by Dr MONRO *primus*, - - 307
Of the Substance, like Cartilage, in which Bone is formed, 308

SECT. II.

General Observations on the Ligaments, - 309
Comparison between the Structure of the Capsular Ligaments of the Joints and Bursæ, and of the Apparatus by which the Synovia of the Joint is secreted, by Dr MONRO *secundus*, - - 313
Of the Source of the Synovia, - 316
— the Cartilages within the Bursæ Mucosæ and Joints, by Dr MONRO *secundus*, - 325

SECT. III.

Of the Particular Ligaments.

Ligaments of the Head, - - 326
Ligaments of the Vertebræ, - 327
Ligaments of the Ribs, - 328
Ligaments of the Breast-Bone, - ib.
Sir A. COOPER's Observations on Ligaments passing between the Coronoid process to the Olecranon, 332
Ligaments of the Superior Extremity, - 329

SECT. IV.

Page.
Of the Ligaments of the Pelvis and Inferior Extremity, 335
Of the Synovial Apparatus of the Knee-Joint, - 342

PART III.

CHAP. I.

OF THE MUSCLES AND TENDONS.

SECT. I.

General Observations on the Muscles and Tendons, 347
Of the coverings of Muscles, - - 348
Bloodvessels of Muscles, - - 349
Lymphatic Vessels of Muscles, - ib.
Nerves of Muscles, - - 350
Tendons of Muscles, - - 351
Of Penniform, Semi-Penniform, and Compound Penniform Muscles, - - 352
Origin and Insertion of Muscles, - - 353
Chemical Analysis of Muscles, - - ib.
Nomenclature of Muscles, - - 354
Classification of Muscles, - - ib.
Contraction of Muscles, - - 355
Observations of Sir E. HOME on the Contraction of Muscles, 355
Muscles, Voluntary, Involuntary, and Mixed, - 356
Relaxation of Muscles, - - 358
Observations on the Collocation of Muscles, - 360
Strength of Muscles, - - 362
Of Oblique Muscles, - - 365
Antagonist Muscles, - - 373
Velocity of Muscular Action, - ib.
Effect of Custom on Muscular Action, - ib.
Effects of Imitation and Sympathy upon Muscular Action, ib.
Effects of Passions of the Mind on Muscular Action, 374
Authors on the Structure and Action of Muscles, 375

SECT. II.

General Observations on the Bursæ Mucosæ, Vesicæ Unguinosæ, or Bursæ Synoviales, - 375

Page.
Lymphatic Vessels of Bursæ, - - 377
Nerves of Bursæ, - - - ib.
Authors upon the Bursæ Mucosæ, - ib.

CHAP. II.

Sect. I.

Of the Muscles of the Head and Neck, - 378
Second Layer. - - 379
Third Layer, - - ib.
Occipito-Frontalis Muscle, - 380
Muscles which move the Lower Jaw, and which are subservient to the Mastication of the Food, - 380
Temporo-Maxillaris Inferior, or Temporal Muscle, ib.
Zygomato-Maxillaris, or Masseter, - 381
The Pterygo-Maxillaris Minor, Superior, or Pterygoideus Externus, - - ib.
Pterygo-Maxillaris Major, Inferior, or Pterygoideus Internus, - - 382
Mastoido-Mentalis, or Digastricus, - ib.
Muscles of the Cheeks and Lips, - 383
The Labials, or Orbicularis Oris, - ib.
Zygomato-Labialis Major and Minor, or Zygomaticus Major and Minor, - - 384
Super-Maxillo-Labialis Major et Medius, or the Levator Labii Superioris Alæque Nasi, - ib.
The Super-Maxillo-Labialis Minor, or the Levator Anguli Oris, - - ib.
The Maxillo-Labialis Inferior, or the Depressor Anguli Oris, - - - - 385
The Mento-Labialis, or Depressor Labii Inferioris, ib.
Levator Menti, or Levator Labii Inferioris, - ib.
Depressor Labii Superioris et Alæ Nasi, - ib.
Bucco-Labialis, or Buccinator, - ib.
Muscles of the Palate, - - 386
Disposition of the different layers of muscles of the forepart of the Neck, - - ib.
Observations on the relation of the Subclavian Artery to the Sterno-cleido Mastoid Muscle, - 388
Disposition of the muscles of the Os Hyoides and Tongue, 389

Page.
Muscles for moving the Os Hyoides, - 390
Muscles of the Pharynx, - - 392
Muscles of the Glottis, - - ib.

SECT. II.

Of the Tendinous Aponeuroses, and Muscles of the Parietes of the Abdomen, - - - 392
Of the Superficial Fascia, - - ib.
Of the Costo-Abdominalis, or External Oblique Muscle of the Abdomen, - - - 393
Ilio-Abdominalis Medius, or Obliquus Abdominis Internus, 396
Lumbo-Abdominalis, or Transversus Abdominis, ib.
Sterno-pubalis, or Rectus Abdominis, - 397
Pubio-sub-umbilicalis, or Pyramidalis, - ib.
Of the Inguinal Canal of the Adult, - ib.
Of the Crural Sheath, - - 399
Of the Crural Aperture, - - ib.
Of the Fascia Transversalis, - - 400
Of the Fascia Lata of the Thigh, - - 401
Inferences from the descriptions of the muscles of the Parietes of the Abdomen, relative to different kinds of Ruptures, - - - 402
Of the Inguinal Canal of the Fœtus, by Mr A. BURNS, 409

SECT. III.

Muscles situated upon the back-part of the trunk of the body, - - - 417

Muscles of the Spine.

Sacro-Spinalis, or Longissimus Dorsi, - 419
Sacro-Costalis, or Sacro-Lumbalis, - ib.
Transversalis Colli, - - 420
Cervicalis Descendens, - - ib.
Spinalis Dorsi, - - - ib.
Transverso-Spinalis Colli, or Semi-Spinalis Colli, - ib.
Transverso-Spinalis Dorsi or Semi-Spinalis Dorsi, - 420

SECT. IV.

Of the Muscles which move the Head.

Movements of the Head, - - 421

Page.
Cervico-Mastoideus, or Splenius Capitis, - 422
Trachelo-Occipitalis, Biventer Cervicis of ALBINUS, or Complexus Major, - - ib.
Trachelo-Mastoideus, or Complexus Minor, - ib.
Axoido-Atloideus, or Obliquus Capitis Inferior, - 423
Atloido-sub-Mastoideus, or Obliquus Capitis Superior, ib.
Rectus Capitis Posticus Major, or Axoido-Occipitalis, ib.
Atloido-Occipitalis, or Rectus Capitis Posticus Minor, ib.
Trachelo-sub-Occipitalis Major, or Rectus Capitis Anticus Major, - - - 424
Trachelo-sub-Occipitalis Minor, or Rectus Capitus Anticus Minor, - - - ib.
Atloido-sub-Occipitalis, or Rectus Capitis Lateralis, ib.
Prædorso-atloideus, Longus Colli, - ib.

SECT. V.

Muscles on the fore-part of the Trunk of the Body, 425

SECT. VI.

Of the Muscles by which the Respiration is performed, ib.

SECT. VII.

Of the Muscles of the Perinæum and Anus, - ib.

SECT. VIII.

Of the Tendinous Aponeurosis of the Superior Extremity, and Muscles proper to it, - - 425
Epitrochlo-Palmaris, or Palmaris Longus, - 427
Palmaro-Cutaneus, or Palmaris Brevis, - ib.

SECT. IX.

Of the Muscles of the Shoulder.

Costo-Scapularis, or Serratus Anticus Major, - ib.
Trachelo-Scapularis, or Levator Scapulæ, - ib.
Costo-Coracoideus-Scapularis, Pectoralis Minor, - ib.
Dorso-sub-Acromialis, or Trapezius, - 428
Dorso-Scapularis, or Rhomboideus, - ib.
Costo-Clavius, or Subclavius, - - ib.
Scapulo-Hyoideus, or Omo-Hyoideus, - 429

SECT. X.

Of the Muscles of the Arm.

Page.
Sterno-Humeralis, or Pectoralis Major, - 429
Lumbo-Humeralis, or Latissimus Dorsi, - ib.
Super-Scapulo-Trochitereus Parvus, or Supra-Spinatus, 430
Super-Scapulo-Trochitereus Magnus, or Infra-Spinatus, ib.
Super-Scapulo-Trochitereus Minimus, or Teres Minor, ib.
Scapulo-Humeralis, or Teres Major, - 431
Sub-Scapulo-Trochineus, or Sub-Scapularis, - ib.
Sub-Acromio-Humeralis, or Deltoideus, - ib.
Coraco-Humeralis, or Coraco-Brachialis, - 432

SECT. XI.

Muscles of the Fore-arm.

Flexor Muscles.

Scapula-Radialis, or Biceps Flexor Cubiti, - 432
Humero-Ulnaris, or Brachialis Internus, - 433

Extensor Muscles.

Olecrano-Scapularis, or Triceps Extensor Cubiti, - ib.
Epicondylo-Ulnalis, or Anconeus, - 434
Of the effect of the above Muscles in cases of Fracture of the Humerus, - - ib.

SECT. XII.

Supinator Muscles.

Humero-Super-Radialis, or Supinator Radii Longus, 435
Epicondylo-Radialis, or Supinator Radii Brevis, - ib.

Pronator Muscles.

Epitrochlo-Radialis, or Pronator Radii Teres, - ib.
Ulno-Radialis, or Pronator Radii Quadratus, - 436

SECT. XIII.

Muscles of the Hand.

Muscles of the Carpus and Metacarpus, - 436
Epitrochlo-Metacarpeus, or Flexor Carpi Radialis, - 437

Page.
Epitrochlo-Carpalis, or Flexor Carpi Ulnaris, - 437
Humero-Super-carpeus, or Extensor Carpi Longior, - ib.
Epicondylo-Super-Metacarpeus, or Extensor Carpi Brevior, ib.
Ulno-Super-Metacarpeus, or Extensor Carpi Ulnaris, - 438

SECT. XIV.

Muscles of the Fingers and Thumb, - - ib.

SECT. XV.

Bursæ Mucosæ of the Superior Extremities.

Bursæ in the vicinity of the Shoulder-joint, - 444
Bursæ Mucosæ situated near the Elbow-joint, - ib.
Bursæ of the inferior part of the Fore-arm and Hand, 445

SECT. XVI.

Muscles of the Pelvis and Inferior Extremities, - ib.
Ilio-Costalis, or Quadratus Lumborum, - - 446

SECT. XVII.

Of the Tendinous Aponeurosis of the Inferior Extremities, and Muscles proper to it, - - ib.
Ilio-Femoralis, or Tensor Vaginæ Femoris, - 447

SECT. XVIII.

Muscles inserted into the Trochanter Major.

Sacro-Femoralis, or Glutæus Maximus, - 448
Ilio-Trochanterus Major, or Glutæus Medius, - 449
Ilio-Trochanterus Minor, or Glutæus Minimus, - ib.
Sacro-Trochanterus, or Pyriformis, - - ib.
Sub-Pubo-Trochanterus, or Obturator Internus, - ib.
Ischio-Trochanteri, or Gemini, - - 450
Ischio-Trochanterus, or Quadratus Femoris, - ib.

SECT. XIX.

Muscles inserted into the Trochanter Minor, which are Flexors of the Thigh.

Præ-Lumbo-Trochanterus, or Psoas Magnus, - ib.
Ilio-Trochanterus, or Iliacus Internus, - - ib.
Pubo-Femoralis, or Pectinalis, - - 451

Page.
Sub-Pubo, Sub-Pubi, Ischii-Femorales, or Triceps Adductor Femoris, - - - ib.
Sub-Pubo-Trochanterus Externus, or Obturator Externus, ib.

SECT. XX.

Muscles of the Leg.

Ilio-Rotularis, or Rectus Anterior Cruris, - 452
Middle of the Trifemoro-Rotularis, or Cruralis, - ib.
Outer share of the Trifemoro-Rotularis, or Vastus Internus, 453
Inner share of the Trifemoro-Rotularis, or Vastus Externus, 453
Observations by LOWIS, CHESELDEN, and my Father, on the Double Incision in cases of Amputation, - ib.
Observations on the Laceration of the Tendon common to the Four Extensor Muscles of the Leg, by Dr MONRO *2dus*, ib.
Biceps Flexor Cruris, - - - 454
Ischio-Sub-Tibialis, or Semimembranosus, - ib.
Ischio-Prætibialis, or Semitendinosus, - ib.
Ilio-Præ-Tibialis, or Sartorius, - - 455
Pubo-Prætibialis, or Gracilis, - - ib.
Poplito-Tibialis, or Popliteus, - - ib.
On the Effect of the muscles fixed into the Thigh-bone, in cases of Fracture and Dislocation of the Thigh-bone, by Mr POTT and the French Surgeons, - 456

SECT. XXI.

Muscles of the Ankle or Tarsus, and of the Metatarsus, 457
Tibio-Super-Tarseus, or Tibialis Anticus, - ib.
Tibio-Sub-Tarseus, or Tibialis Posticus, - 457

Of the Muscles which arise from the Perone or Fibula.

Peroneo-Tarseus, or Peroneus Longus, - 458
Peroneo-Metatarseus Magnus, or Peroneus Brevis, ib.
Gastrocnemius, - - - 459
Observations on Laceration of the Tendo Achillis, by Dr MONRO *Primus*, - ib.
Tibio-Calcaneus, or Soleus, - - ib.
Femori-Calcaneus, or the Plantaris, - 460

SECT. XXII.

Muscles of the Toes, - - 460

Pages,

SECTION XXIII.

Of the Bursæ of the Inferior Extremities, - 464

PART IV.

CHAP. I.

ORGANS OF DIGESTION.

General Observations upon the Structure and Functions of the Organs of Digestion, in the different Classes of Animals, - - - - 469

CHAP. II.

Of the Particular Organs by which the Food is prepared, before it passes into the Stomach, - - - 474

SECT. I.

Of the Teeth of different Animals, - 478
— the Human adult Teeth, - - 483
— the Formation of the First Set of Teeth, - 486
Analysis of the bony part of the Teeth, by BERZELIUS, 487
Of the Formation of the Enamel, - - 488
— the period at which the First Set of Teeth, or Temporary Teeth, appears, - - - 490
— the Shedding of the First Set of Teeth, and of the appearance of the Second Set, - - 491
— the Formation of the Second Set of Teeth, - 492
Changes in the Teeth and Jaws in advanced life, - 493
Of the Form of the Under Jaw at different periods of life, 494

SECT. II.

Of the Soft Parts of the Mouth, and its Appendages, 495

SECT. III.

Of the Palate, - - - 496
The Petro-Palatinus, or Levator Palati, and other Muscles of the Palate, - - - 497

Page.

Sect. IV.

Of the Tonsils, 499
— Inflammation of the Tonsils, ib.

Sect. V.

Of the Tongue, its Papillæ, and of its several Muscles, 500

Sect. VI.

Of the Salivary Glands, 503
— the Submaxillary Gland, 504
— Ramula, 505
— the Sublingual Gland, 506
— the Secretion of Saliva, proof that it is independent of the pressure of the Under Jaw, ib.
Chemical analysis of the Saliva, 507

Sect. VII.

Of the Pharynx and Gullet.

Of the Pharynx, 508
Stylo-Pharyngeus, 509
Of the Gullet, 510
— Swallowing, 511
— Defect of the Gullet, 512

CHAP. III.

Sect. I.

Of the Regions of the Abdomen, and of the Peritonæum, 513
— the Peritonæum, 514

Sect. II.

Observations on the Human Stomach, by Mr Hunter, Sir E. Home, Mr William Cowper, Morgagni, Walter, &c., 519
Of the Coats of the Stomach, 521
Dr Yellowly's Observations on the Villous Coat of the Stomach, 522
Microscopical Observations on the Stomach, by Dr Brewster and Mr Bauer, 523

Page.

Sect. III.

Of Chymification, or of the Changes which the Food undergoes within the Stomach, - - 524

Sect. IV.

Observations on the Gastric Juice, by Dr Monro *Secundus*, Stevens, Young, &c., - - - 526

Sect. V.

Of the Intestinal Canal, - - 533
— the Jejunum and Ileum, - - 535
— the Ilio-Colic Valve, - - 536
— the Appendix Vermiformis, - - 537
— the Mesentery, - - 538
— the Larger Intestines, - - 539
Observations on Intestinal Concretions, by Drs T. Thomson Marcet, and Dr J. Davy, - - 541
Of the Coats of the Smaller Intestines, - 546
Peritonæal Coat, - - ib.
Muscular Coat, - - - ib.
Cellular Coat, - - - 547
Villous Coat, - - - 548
Of the Mucous Glands of the Intestines, - 549
— the Coats of the Rectum, - - ib.
— Structure and Malconformation of the Rectum, 550
— Chylification, or of the Change which the Food undergoes within the Duodenum, - - 552
Analysis of Feculent Matter by Berzelius, - 553
——— of Air in the Intestines, - - 554

CHAP. IV.

Sect. I.

Of the Liver of the Adult, - - 554
— the Situation of the Liver, - - 555
— the Coats of the Liver, - - 557
— the Ligaments of the Liver, - - 558
Observations on the Unusual Distribution of the Bloodvessels of the Liver, by Messrs Abernethy and Wilson, 564

Page.
Of the Source of the Bile, - - 562
— the Internal Organization of the Liver, - 566
Dr Brewster's Microscopical Observations on the Liver, ib.
Analysis of the Parenchema of the Liver, by Braconnet, 567
Of the Nerves of the Liver, - - 568
— the Lymphatic Vessels, - - 569
— the Biliary Ducts, - - 570
— the Coats of the Gall-Ducts, - - 571
Experiments of Dr Monro *secundus*, on the Gall Ducts, 572
Of the Gall-Bladder, - - 573
— the Coats of the Gall-Bladder, - 575

Sect. II.

Of the Liver of the Fœtus, - - 576
Mr Bryce's Observations on the Liver of the Fœtus, 577
Of the Bile, - - - 578
— the Chemical Analysis of the Bile, - ib.
— the Uses of the Bile, - - - 580
Experiments on the Bile, by Dr Monro *secundus*, 581

Sect. III.

Of Biliary Calculi, by Dr J. Davy, - 583

Sect. IV.

Of the Spleen, - - - 597

Sect. V.

Of the Pancreas, - - 599
De Graaf's Experiments on the Pancreatic Juice, 600

Sect. VI.

Of the Omenta, - - - 600
— the Course of the Peritonæum, - 601
— the Capsule of Winslow, - -

Directions to the Binder for placing the Plates.

VOL. I.

PLATE I. to face page 596.

VOL. II.

PLATES II. & III. to be inserted between pp. 68. and 69.
——— IV. & V. to follow page 112.
——— VI. & VII. to follow page 124.
——— VIII. to face page 211.
——— IX. to face page 212.
——— X. to face page 232.
——— XI. to face page 309.
——— XII. to face page 543.

PREFACE.

THIS elementary work is published for the use of Students, in order to facilitate the study of Anatomy, and its collateral and dependent branches of science, Physiology, Pathology and Surgery.

Some years ago I was induced, in consequence of the urgent solicitation of my pupils, and some other friends, to publish an Outline of my course of Lectures on Anatomy, that its plan and details might be more readily and fully understood.

Another motive also prompted me to become an author. I was then anxious, and still am so, to convince the public, and especially those friends and patrons who placed me in the honourable situation which I hold, that I have not been inattentive to the obligations it imposed on me; and that in this instance, as in many others, I have been ambitious of treading in the footsteps of my Father and Grandfather, who for many years filled the situation I now hold, with credit to themselves and advantage to their country.

Another motive to publication is now superadded, —the approbation bestowed on my Outlines by the public, which has been much greater than possibly could have been anticipated, considering the limited plan on which they were constructed.

The plan of the present work being more comprehensive, and quite different from that of my Outlines, it seemed necessary to express that change, by a change of the Title. These volumes are therefore entitled, *Elements of Anatomy*. They have been written for the use of Students of that Science in general, as well as for my own pupils; and though, from their title, they may be supposed to relate to the Anatomy of the Human Body in its sound state only, yet, as Comparative Anatomy, Physiology, Pathology and Surgery, are inseparable from Human Anatomy, it seemed impossible to avoid introducing remarks on these very important sciences.

Animal Chemistry has not been overlooked. It has proved a source of much useful information, respecting the various solids and secreted fluids, and also respecting those morbid concretions which are sometimes found in the passages through which the spittle, bile, urine, and other fluids pass, and which prove a source of so much uneasiness, and often of death.

The remarks relating to Physiology, Pathology and Surgery, are necessarily of a limited nature, and such only as arise more immediately out of the Anatomy of the parts concerned.

In accordance with the wishes of booksellers, my Elements have been limited to two volumes, closely printed; containing, perhaps, as much matter as three or four volumes, printed in the style of my Outlines.

There are before the public books upon Anatomy of very different descriptions. There are some authors who have limited themselves to General Anatomy; others to Descriptive Anatomy; a third set to Surgical, and a fourth to Comparative Anatomy.

This mode of subdividing the subject is useful to more advanced Students; but not to the beginner, for whose use I profess to write. The young Student requires an Elementary Book,—which shall embrace all these departments of Anatomy, which shall give general, as well as particular views, and which shall suggest to him some of those inferences which are applicable to Physiology, and to the practice of Surgery. If he be a Student who studies Anatomy as a branch of Natural Philosophy, who wishes to get a view of the Animal Creation, which affords such striking illustrations of the wisdom and power of its Author, it is requisite that that grand plan upon which animals are constructed, and also those deviations which a peculiar economy renders indispensable, should be laid before him by an appeal to the Anatomy of the inferior animals, and by comparing it with that of Man. What can be more uninteresting than purely Descriptive Anatomy, and what more apt to disgust, rather than to encourage, the young Student in the further prosecution of that most important study?

If, on the other hand, the Student wishes to acquire such a knowledge of Anatomy, as is requisite for the Physician, the Surgeon, or the Accoucheur, it is of much moment to point out to him the intimate relation between those sister sciences, which have been reared upon the basis of Anatomy; and to shew that, to neglect Anatomy, is to neglect laying a solid foundation-stone, and is like building a house upon the sand.

In each department, after having premised a few general observations, a more detailed account is given, interspersed with such observations upon the Anatomy of the Inferior Animals, as are calculated to throw light on the Structure or Functions of the human

frame, and also with remarks relative to Pathology and Surgery.

It has never escaped my thoughts for a moment, that the Healthy Anatomy is cultivated chiefly to assist the medical practitioner in ministering to the ailments and distresses of mankind; and that this application constitutes the professional value of the science.

It may be right to inform the reader, that the descriptions have been frequently compared with nature. It may also be proper to notice, that the descriptions of all parts are not given with the same detail; for I conceive it of much more moment that the Student of Medicine or Surgery should be intimately acquainted with the structure and functions of the brain, and of the bowels contained within the chest, belly, and pelvis, than with the muscles of the back, or with the more minute ramifications of the bloodvessels and nerves.

Particular attention has also been given to the course of the larger bloodvessels and nerves; and also to the lateral communications of the branches of the arteries, by which the circulation of the blood is carried on, when the main trunk of the artery has been obstructed.

To the surgeon this knowledge is of the utmost importance, in the treatment of the various accidents and diseases to which the bloodvessels are exposed, and in performing the various operations of surgery.

In my Outlines of Anatomy, too little was said respecting Operative Surgery. For this omission, I have endeavoured to make amends in these volumes, in which, remarks will be found upon the greater number of operations of surgery; and many details are added upon the operation for the cure of Aneurism, the Stone,

and Ruptures, to the safe performance of which much anatomical skill is requisite.

From having had various opportunities of studying nature in her truest colours, by a careful examination of the healthy human subject a few hours only after violent death, I have endeavoured to convey to the mind of my reader a correct idea of the colour of the internal parts of the living body. This kind of knowledge may prove essentially useful to the surgeon when he is required to determine, in cases of fracture of the skull where the brain has been exposed, or in cases where a portion of the intestines has been exposed, whether these be inflamed or not; and in various other accidents and operations of Surgery, this knowledge must also be useful.

The examination of the body, while still warm, may furnish data for determining, whether in the living body there be any watery fluid within the ventricles of the brain,—between the capsule and body of the crystalline lens,—and within the pericardium, and may be useful also to the Student of Medical Jurisprudence.

In this work care has been taken to introduce those observations upon the minute structure of several organs which elude our unassisted sight, and are discoverable only by the use of the microscope. In this department I have received considerable assistance from that distinguished philosopher Dr Brewster, and from the observations of Mr Bauer.

These volumes will be found to contain much valuable and original information, which I have derived from the manuscripts of my Grandfather and Father, and from my medical colleagues and other friends; and I have endeavoured to include all the most mo-

dern improvements in Anatomy, Physiology, and Surgery, contained in many very expensive books, in Transactions of Learned Societies, and in some Periodical Journals, to which few Students have access.

Descriptions in language, however carefully drawn up, being inadequate to convey distinct impressions on many points of anatomy, it seemed necessary to illustrate the text by several Engravings.

I have not given, excepting in one instance, engravings representing relative situation; for in an octavo book, such representations must necessarily have been so diminutive as to have conveyed little information as to the subjects depicted.

Having stated so much regarding the general scope of my work, it may not be improper to subjoin a brief sketch of its several component parts, and of those additions or improvements most worthy of the attention of the reader.

Part I. is dedicated to general observations respecting the animal frame, and to the examination of its component, solid and fluid parts.

On the construction of the skeleton much has been added of my own, and also from the Lectures of Sir E. HOME and of CUVIER; and on the proportions of its several component parts, from LEONARDO DA VINCI, SŒMMERING, and Sir ANTHONY CARLYLE.

Dr JOHN DAVY was so polite as to repeat many of his experiments on the chemical analysis of the bones, to add to the valuable table, of which I published the original in my Outlines.

A part of the description of the particular bones has been derived from my Grandfather's Osteology; which, though published nearly 100 years ago, still

retains its rank as one of the classics in Anatomical Science. But I found it necessary to alter and to add a great deal; and I have also borrowed liberally from an interleaved and corrected copy of the author, both as to the descriptive and pathological departments.

Much additional matter has also been given respecting peculiarities in the structure of the skeletons of the inhabitants of different parts of the globe, and especially regarding the pelvis in its natural and deformed state.

The museum of my colleague Dr HAMILTON contains many valuable specimens of deformed Pelves; and, in particular, those of seven women who had undergone the Cæsarean operation, and to these I have, through the liberality of my colleague, had free access.

I have also given a place to some remarks on the distortion of the male pelvis,—a subject hitherto too much neglected, and which has sometimes proved a barrier to the performance of the lateral operation of lithotomy.

Several remarks, which, as far as I know, are proper to myself, have been introduced, respecting malconformation of the spine in Negroes; and also some important observations by MARET and HOCHSTETTER, respecting the state of the spine in spina bifida. Much valuable matter has been added from the observations of Sir ASTLEY COOPER, on fractures deeply seated and dislocations of the bones.

Within these few years, great attention has been devoted to the form of the Skull, and to the relative size of different parts of it. It has been assumed, that these indicate the size of the portions of subjacent brain; and that they thus form an index to the faculties and propensities of the mind. The form of the skulls of the inhabitants of the different regions

of the globe, has also attracted much notice. I have therefore most materially enlarged, and, I should hope, improved this part of my work, from many authentic sources. My own collection of skulls has been lately much increased; the Museum of Natural History of this University is also rich in this department; and the Museum of the Phrenological Society of this City, contains a number of curious specimens. These have been the principal sources from which my observations have been derived; and I owe much to the liberality of my colleague Mr JAMESON, and also to that of Mr COMBE, for unreserved access to the collections under their more immediate superintendance. My other friends have also rendered me much assistance in this curious investigation.

Sir WALTER SCOTT permitted me to examine the curious skull sent to him from Greece, by Lord BYRON.

To the following gentlemen, who were resident for some time amongst the people they have described, I am very much indebted for particular and authentic information.

Dr HOLLAND has communicated some curious facts respecting the form of the head of the natives of Albania; Dr DAVY, respecting those of Ceylon; Dr KNOX, respecting the natives of Southern Africa; and Mr EDWARDS and Mr FISHER, the companions of Captain PARRY, and Dr RICHARDSON, the companion of Captain FRANKLIN, respecting the Esquimaux, and Indians of Northern America.

To Mr EDWARDS and Mr FISHER I am also much indebted for four skulls of the Esquimaux, of persons of different ages, and which were obtained at different parts of the Arctic shores.

To Sir A. HALLIDAY I owe much. He has sup-

plied me with several skulls of the inhabitants of different remote countries, and particularly with those of the natives of the Islands of the Pacific Ocean, and of Van Dieman's Land.

As so much has been lately written respecting the arch of the fore-head, and the frontal sinuses, I felt it to be a duty to devote my particular attention to this part of osteology; and, to prevent all undue bias, examined with care the numerous specimens which are in the Museum of the University, as illustrative of this part of anatomy. It may not be improper to add, that I only met with three out of forty-three specimens in adult skulls, in which there was no vestige of an intervening space between the plates of the frontal bone.

In Part II., which treats of the cartilages, synovial apparatus, and ligaments, my Grandfather's account is given of the mechanism of the intervertebral cartilages which he discovered; and the structure of the capsular ligaments of the different joints is compared. The observations upon this subject are chiefly derived from my Father, who was the first (as far as I know) who pointed out the identity between the structure of these, and other serous membranes; and who also proved, that serous membranes are liable to peculiar organic derangements.

Part III. which relates to the muscles, tendons, and bursæ mucosæ, has undergone a careful revisal. The descriptions of the muscles, and of their mode of action, have been extended; and it has been my aim to render my Father's observations on the oblique muscles more intelligible to those who are not deeply conversant with mathematics.

From the description of the muscles of the abdomen, and parts connected with these, many inferences are drawn, relative to the different kinds of herniæ, or ruptures; and, when treating of the muscles of the extremities, observations on the position of the limbs in cases of fracture, dislocation of the bones, and in cases of laceration of the tendons of the muscles.

In Part IV., which treats of the organs of Mastication, Deglutition, Chymification, and Chylification, a very enlarged view is given of the organs subservient to these purposes in Man, and many of the inferior animals. Mention is made of the natural peculiarities of the human teeth, and of those which occur in many of the inferior animals, and of the chemical analysis of the enamel and osseous part of the teeth, by BERZELIUS and PEPYS. An account is also given of the discovery, by Mr CORSE, of the structure and succession of the teeth of the elephant.

In treating of the structure of the stomach, I have been favoured with a description of its internal surface, by my distinguished friend Dr BREWSTER, and I have added also the remarks of Mr BAUER and Dr YELLOWLY, upon the same subject. On the changes which the food undergoes within the Stomach, I have made many important extracts, from the observations of my Father, Dr WILSON PHILIP, Dr HASTINGS of Worcester, CHEVREUL, and Dr PROUT.

I have given a very enlarged account of the Structure of the Liver, and of the nature of the Bile; and have inserted an unpublished account of a very unusual distribution of the bloodvessels of the Liver, with which I was favoured by my late friend Mr WILSON, teacher of Anatomy in London.

Considerable light has been thrown upon the minute structure of the liver of the Sheep by the microscopical observations made upon that organ by Dr BREWSTER. I have inserted also the observations of Mr BRYCE upon the occasional deficiency of the Gall-bladder of the adult, and upon the Liver of the Fœtus, and an account of the numerous experiments made upon the Bile by my Father. Notice has also been taken of the Chemical Analysis of the Bile, by THENARD, and by Dr JOHN DAVY. Through the kind offices of my friend Dr DAVY, I have been enabled to present to my reader a great number of valuable and original observations upon the chemical nature of Gall-stones, and which I believe, I may add, is the most complete account of the analysis of gall-stones that has hitherto been published.

In treating of the organs of Circulation and Respiration, I have given an account of the more recent observations upon the blood by PREVOST and BLUNDELL, and have made particular mention of the result of an experiment of my colleague Dr DUNCAN *junior*, which has not yet been before the public, overturning an opinion of a celebrated author, and proving that *no air* is extricated during the coagulation of the blood under the atmospheric pressure.

I have made mention also of the very important experiments of Dr WILSON PHILIP, upon the laws which regulate the vital functions, and especially of those as to the relation of the Circulating and Nervous Systems.

The experiments of my Father, concerning the Circulation of the Blood, the Influence of the Heart, and of the Arteries, in promoting the circulation of the blood, and on the nature of Inflammation, are also inserted.

The observations upon Secretion have been illustrated by engravings, representing the minute structure of the Mamma; and in examining these, the reader will no doubt be struck with the great similarity in the disposition of the smaller branches of the lactiferous ducts, to that of the vessels in many of the productions of the vegetable kingdom. The same observation may be extended to the engravings I published in my Outlines of Anatomy, representing the minute structure of the Kidneys.

In treating of the Lungs, I have inserted a paper on the minute structure of these organs, which was written by my Father, and read to the Royal Society, at a meeting held January 1767, but never published, containing all the knowledge we now possess regarding the structure of these important organs, with the exception of one or two facts lately discovered by Reisseisen.

I have also noticed the experiments of Dr Davy, regarding the extrication of air from the air-cells of the lungs into the pleura. I have inserted a paper by Dr Godwin, on Respiration, from an unpublished manuscript, which he sent to my Father, and also the results given by Dr Edwards of Paris, the latest author upon Respiration; and likewise the observations of my Father on the means of recovering persons apparently drowned, and injecting fluids into the stomach, by an instrument which he contrived for that purpose, and by which the contents of the stomach may be afterwards extracted. I have also added a short account of that remarkable disease called by the French *Melanosis*, in which a substance like charcoal is deposited in different parts of the body. The observations upon this remarkable disease, have

been deduced from various original sources of information, which have lately fallen under my own notice. The state of the Lungs of the Fœtus has also been described, and as inferences from that, some remarks by CARPURON and HUTCHINSON, on the natural causes of death after delivery.

In treating of the Organs of Urine, I have enumerated the observations of BERZELIUS, MAJENDIE, HENRY, ROSE, WILSON PHILLIP, and PROUT, who have shewn the relations of certain states of the urine, with certain symptoms of disease.

The very ample account which has been given of the Organs of Urine and Generation, was the result of a careful examination of the bodies of three criminals. To my assistant Mr MACKENZIE, who took very great pains in tracing the course of the muscular fibres of the bladder of urine, I am indebted chiefly for information on that head. As inferences from the descriptive part, remarks have been made on Phymosis, Paraphymosis, Castration, Amputation of the Penis; on introducing Instruments into the Urethra; on the different methods of performing Lithotomy; on Puncturing the Bladder; and on the Dilatation of the Urethra, so as to extract stones from the bladder.

In treating of the Female Organs, I have introduced the remarks of BŒHMER and Sir EVERARD HOME, upon the Structure of the Ovaria; the remarks of Dr GRANVILLE upon the same subject; and those of Dr WILLIAM HUNTER and TIEDEMANN, upon the Nerves of the Womb; and also remarks on the displacement of that organ.

I have also made mention of the peculiarities of the Female Organs of the Hottentot.

The Plates which illustrate the structure of the Ovaria, were copied from drawings made forty years ago,—a fact of which it seems necessary to make particular mention, as they bear some resemblance to those of Sir EVERARD HOME.

In describing the course of the Arteries and Veins, I have directed the attention of the reader chiefly to the larger branches, the course of which it is of great moment to understand, as they are liable to be wounded, and to become diseased; for the relief of which the aid of the surgeon is required.

I have inserted, in their own words, Sir ASTLEY COOPER'S mode of operating for the cure of Carotid Aneurism;—the operation of HEDENUS of Berlin for extirpating the Thyroid Gland;—Mr COATS'S method of taking up the Thyroidal Artery;—the observations of Professor COLLES of Dublin, and of Mr LISTON of this city, on taking up the Subclavian Artery:—the observations of Mr J. HUNTER, Mr ABERNETHY, and Sir ASTLEY COOPER on Iliac and Popliteal Aneurisms.

To the description of the Veins of the Superior Extremities, are appended some remarks upon the operation of Venesection, and the consequences which sometimes flow from that operation; and also respecting the consequences of slight wounds of the fingers, which sometimes prove fatal. I have concluded this part of my Work, by an account of Dr PARRY'S observations on the formation of new arteries, when a ligature has been put upon the trunk of an artery, and by describing the distribution of the arteries and veins upon the face of a stump,—of which, as far as I know, no account has hitherto been published.

Part VI. relates to the Nervous System, in which I have endeavoured to give an explanation of the Structure of the Brain and Nerves in Man, and many of the inferior animals, interspersed with various observations, which have been deduced from experiments made by myself, or from the phenomena of disease.

I have inserted my Father's observations on his discovery of the communication between the lateral ventricles of the brain, and various pathological observations upon that subject, which have never been published; and also his remarks respecting the fourth ventricle and spinal cord.

From the works of VIEUSSENS, MALPIGHI, REILL, ALBINUS, my Father, PROCHASKA, Sir E. HOME, the WENZELS, WILSON PHILIP, C. BELL, LOBSTEIN, BOCK, WEBER, WALTER, WUTZER, LOBSTEIN, SŒMMERING, LAWRENCE, TIEDEMANN, SERRES, SWAN, ROLANDO, FLOURENS, GREDING, HASLAIN, PINEL, VAUQUELIN, THENARD, &c. many observations and details respecting the Structure and Functions of the Brain and Nervous System, have been extracted.

In describing the Organs of the Senses, many observations are introduced upon the Physiology and Pathology of these organs.

In treating of the different Senses much additional matter has been given.

In describing the Nose, notice has been taken of the late experiments of MAJENDIE, and of the extraction of polypi from that organ.

In describing the Eye, I have inserted the more recent remarks by Dr KNOX, and by my late pupil, Dr JACOB of Dublin.

A number of remarks upon the Retina and Foramen of Sœmmering are introduced; and the discovery by Dr Knox of the existence of that foramen in Lizards; and also the remarks of Comparetti, of Dr Young, and Haldat, upon the sensibility of different parts of the Retina.

Upon the structure of the Crystalline Lens, the remarks of Zinn, Petit, my Father, Leeuwenhoek, Dr Brewster, Mr Ramsden, and Dr Young, are inserted.

The experiments of Mr Mayo, with a view to determine the cause of the movements of the iris, and a few observations upon the different kinds of inflammation of that organ, are subjoined; and also a few remarks upon the different kinds of cataract; the operations required for these; and upon squinting; together with Mr C. Bell's remarks upon the Nerves of the Orbit.

When treating of the Eye-lids, I have introduced an account of the recent discovery of a new muscle, by Dr Horner of Philadelphia, who was lately so polite as to send me his *Lessons on Practical Anatomy.*

The observations of Sir E. Home upon the Structure of the Membrane of the Drum, are introduced, in treating of the Organ of Hearing; those of Mr Goldingham, and Mr Biot, upon the Transmission of Sound through different media; and the experiments of my Father on the Eustachian Tube.

I have been induced, from various considerations, to deny the existence of the aqueducts described by Cotunnius, and to consider them to be venous canals.

In treating of the Tongue, and its functions, some remarks are introduced upon the sense of taste in

different animals, and upon the use of the Papillæ; and also the observations of BLUMENBACH upon the Palate, as being the seat of the sense of taste.

I have also directed the attention of the reader to the means of stopping bleeding from the tongue; to the safest method of removing portions of that organ, when in a cancerous state; to the cutting of the Frænum Linguæ; and to Ranula.

Several observations are introduced, when treating of the Sense of Touch, upon the acuteness of this sense and of that of Smell, in the blind; and upon the colour of the skin of the inhabitants of different parts of the globe.

In describing the course of the particular nerves, various observations relative to the uses and to the diseases of particular nerves are introduced. Many of the observations of Mr SWAN, Mr C. BELL, Mr WALLACE, Dr HENNEN, LARRY, and other authors, are noticed.

In describing the Sympathetic Nerve, I have given the various opinions of BOCK, LOBSTEIN, and others on that head. The experiments of LOBSTEIN on that remarkable nerve, and also several made by myself, have also been mentioned.

The attention of the reader has been directed, in an especial manner, to the Anatomy of the Spinal Cord, at various periods of life; and to the discoveries of Mr C. BELL, as to the nerves connected with it; to which are added the results of the observations of Dr WILSON PHILIP, on the Spinal Cord, upon the Heart, and other organs.

Part VII. of the Elements is devoted to the description of the Lymphatic or Absorbent System.

In treating of the Lymphatic System, many observations respecting its origin, course, termination, and more particular structure and functions are premised, as being introductory to the description of the particular branches of this system.

Part VIII. treats of the Gravid Womb, and its contents. To this part some important additions have been made, which were suggested to me by my colleague Professor HAMILTON and by Dr REID; and I have not omitted to make mention of the discoveries of Sir E. HOME as to the fœtus in utero.

From the above very rapid sketch of the contents of the several parts of these volumes, the reader may, I trust, be persuaded that I have bestowed much pains in collecting the best materials; so that this work may include all the most modern improvements in the sciences of which it treats.

I have thus filled up the Outline of the Anatomy of the Body in its sound state, but have not even given an Outline of Morbid Anatomy, but only such remarks as arise out of the Sound Anatomy, which necessarily led to notices regarding the greater number of the Operations of Surgery, of which no mention has been made in my former work.

To conclude; if these volumes shall fulfil the intentions of their author, and prove useful to the student of that science which is the only solid basis of Physiology, Pathology, and Surgery, he will consider himself fully compensated for the time and labour he has bestowed in their composition.

ELEMENTS

OF

ANATOMY.

CHAP. I.

GENERAL OBSERVATIONS.

THE word *Anatomy*, strictly interpreted, implies merely dissection; but it is commonly taken in a more general signification, as comprehending that science by which, through the medium of dissection, we become acquainted with the structure and use of the several component parts of animal bodies.

This science comprehends the Anatomy of the Human Body, and also that of the inferior animals; the points of similarity or dissimilarity observed in their organization constituting *Comparative Anatomy*.

In this work, it is proposed to introduce only as much of the anatomy of the inferior animals, as tends to throw light on the structure and functions of the several parts which enter into the composition of the human frame.

By pursuing such a mode of investigation, we discover a general plan, upon which animals are formed, and which, with various modifications adapted to the species, is followed up through the whole creation.

Animals are of a more simple or complicated structure: hence, by examining the more simple, the structure and uses of the organs in the more complicated become obvious; and we are thereby taught to analyse functions which in man are so complicated as otherwise to elude our research. The existence of an organ, under different modifications, or the want of it, in certain animals, cannot fail to suggest important deductions as to the function of the same organ in the human frame; and, at the same time, to shew that every part of the same organ is not equally sensible, and equally necessary to the prolongation of life. In short, the most striking illustrations and most remarkable discoveries as to the structure and uses of the organs of man, as those of the circulation of the blood and the functions of the absorbent system, have been derived from a careful examination of the anatomy of the inferior animals.

The study of the anatomy of the inferior animals is necessary to the understanding of the names applied to different organs of the human frame by the older anatomists, who directed their attention chiefly to the anatomy of the inferior animals.

The anatomy of animals at large is the only sure basis upon which a natural Classification of animals can be built.

A knowledge of the anatomy of the inferior animals may throw light on Geology.

The bodies of animals are composed of Solids and Fluids, mixed in different proportions; by the mutual action of which, the functions of the living body are performed.

The solids give form and consistence to different parts of the body.

The solids have the form of fibres or plates, of which membranes or cells are formed, destined to contain the fluids.

The solids are the Bones, Ligaments, Muscles and Nerves.

Anatomy, so far as it considers the solids, has been divided into various branches, distinguished by different names, of Greek etymology, expressive of the parts referred to; as

Osteology,	A description of the Bones.
Syndesmology,	Of the Ligaments.
Myology,	Of the Muscles.
Splanchnology,	Of the Bowels.
Adenology,	Of the Glands.
Angiology,	Of the structure and course of the Bloodvessels.
Neurology,	Of the Nerves.

The solids may be separated from the fluids by various means, as by exsiccation, expression, boiling, and putrefaction.

The fluid part forms by far the larger proportion, so that when the body has been dried artificially, or when buried in dry sand, as in Arabia, it loses very much of its weight; I should suppose eight of ten parts.

Of the Solid Parts of the Animal Frame.

These are derived from the fluids. The solids are of different consistence, and therefore have been arranged under two heads, the Hard and the Soft. The latter consist chiefly of what has been called Animal Matter.

The first class comprehends the Bones and Cartilages; and the second the Muscles, Viscera, Nerves, and all other parts.

Some writers have also made mention of a Pulpy Substance, such as enters into the composition of the brain, salivary glands, pancreas, and a few other parts of the body.

The solids, when mechanically divided, may be resolved into Layers, Fibres, or Filaments; and these several fibres are united by cellular substance, which envelopes, pervades, and joins these.

Thus muscles are composed of fibres of a peculiar kind, united by cellular substance.

Bones are also composed of fibres, united by cellular substance, and of jelly, to which earthy matter is added, to give them the necessary solidity and rigidity.

Tendons, ligaments, and the nerves, also consist of fibres.

Thick, strong, and elastic fibres, united by cellular substance, form the Membranes.

The older authors supposed that all the organic solids might be divided into the simple fibre, which was chiefly composed of oil, earth, and iron; which simple fibres, according to HALLER, are invisible, and exist only in the mind's eye.

Fibres, united by compact cellular substance, compose membranes of different textures, which, in structure, are more or less complicated, and which are subservient to different purposes in the animal economy; and of these parts of different texture or tissues, the animal body is an assemblage.

As to the nature of the ultimate structure of the different tissues of the animal body, anatomists are not agreed: probably they consist of cellular and muscular substance, small branches of arteries, and of nerves.

The bodies of animals are composed of several Organs, and the different organs are of a more simple or complicated structure, being made up of one or more Tissues; and it is necessary to study these separately, and to examine how far each of these enters into the fabric of any particular part; and to this department of anatomy, the term General or Analytical Anatomy has been applied.

In whatever part of the body these tissues are placed, they exhibit the same physical and chemical properties, and are liable to peculiar organic derangements. Hence it is an object not merely of curiosity, but of real use, to investigate carefully the nature of the particular tissues, and of the organic derangements to which they are liable.

These tissues possess, individually, different degrees of hardness and elasticity, are different as to chemical analysis, and are composed of the elements and substances above enumerated.

This general anatomy may be said to be of modern date; and, like other great improvements, has gradually arrived at its present state of perfection. In the works of HALLER, an attempt is made to simplify it. He makes mention of a fundamental elementary tissue, adopting the opinions of the older authors; but his was a vague, hypothetical, and unnatural system.

My Father, in his book on the Bursæ Mucosæ, published in 1788, was the first author who pointed out the identity between serous membranes, as the peritonæum, pleura, capsular ligaments, as to their structure, and also that these were liable to similar and peculiar derangements.

In Sect. 7. of that book, he compares together the structure of the Bursæ, with the capsular ligaments of the joints; and, in Sect. 8. he compares the structure of the bursæ with that of the pleuræ, pericardium and peritonæum; and further shews, that these membranes are liable to the same organic disorders, and become highly inflamed by exposure to the air. He observes, (p. 38.), "Wounds of these large sacs of the thorax and abdomen likewise generally produce a high degree of inflammation, attended with the most dangerous consequences." And, in page 34., he says, "Where wounds have accidentally penetrated into the cavities of the joints, or have been made with the intention of evacuating water, or of extracting such cartilaginous bodies, if the wound had not been properly closed, and the joint restrained from motion, a very considerable and painful swelling of the whole joint has ensued, which, in some, has terminated fatally; or, to save life, there has been a necessity of having recourse to the amputation of a limb."

Dr C. Smyth, in his paper* on the different kinds of inflammation, has clearly pointed out the nature of some of the tissues, and has shewn that each tissue is subject to a different kind of inflammation, occasioned by different causes, and followed by different consequences.

"Experience," says Dr C. Smyth, "has long since taught us, that every part of an animal body, the cuticle and hair perhaps excepted, is liable to inflammation; and, by attending strictly to the phenomena, it is equally evident, that, according to the nature of the part affected, the disease puts on a different appearance; is accompanied by different symptoms; is of various terminations; becomes more or less acute or

* London Medical Communications, p. 168. Edition 1788.

chronic; and requires a different, and at times an opposite treatment." I do not, however, pretend to have fully investigated this subject, or to be able to ascertain all the various shades of inflammation, according to the great diversity of structure observable in the different parts of the body. I only propose to give the Outlines of some of the most obvious and striking distinctions originating from this source; and which, as they occur frequently in practice, are of more immediate concern to the practical physician."

The following, then, in my opinion, may be justly considered as distinct Species of Inflammation, each of them having a specific character strongly marked, which, in every instance, seems entirely to depend upon the peculiar structure of the part inflamed.

1. Inflammation of the Skin. Erysipelas.
2. Cellular Membrane. Phlegmon.
3. Diaphanous Membranes.
4. Mucous Membranes.
5. Muscular Fibres.

This new arrangement paved the way to a more minute, accurate, and philosophical examination of the structure and properties of the different organs, and has tended much to the advancement of physiological and pathological knowledge, which has now indeed assumed a new aspect. This same excellent idea was taken up, ten years afterwards, by Dr Pinel and Bichat, who have amplified and extended it beyond bounds.

Grounding, in my humble opinion, on an ill-founded hypothesis, that of an animal and organic life, Bichat has enumerated no fewer than twenty-one different tissues. Some of the late French writers have added what they have called an Erectile Tissue. A mucous tissue is sometimes formed by disease, as that lining fistula; and I have seen a new membrane generated from the serous membranes, as from the dura mater.

Without entering farther into the merits of this subject, I shall merely add, that to me there seem to be only the fol-

lowing eleven simple tissues,—the Cellular, the Bony, the Cartilaginous, Sero-fibrous, Mucous, Muscular, Adipose, and the Tissue of the Skin, the Cuticle, with that of the Hair, and Nerves.

The general systems are the Circulating, Absorbing, and Nervous.

It is not easy to detect the chemical ingredients which enter into the composition of the body, as new compounds are formed during the processes instituted for that purpose, and as many of the constituent principles are apt to escape in a gaseous form, or to elude observation.

Animal substances are prone to putrefaction; oxygen is absorbed, and carbonic acid and ammonia are formed during the putrefaction.

Sir H. Davy has justly observed, that according to the different proportions of the above named principles in the animal economy, so are the changes they undergo different. When there is much saline or earthy matter mixed with them, the progress of their decomposition is less rapid than when their principles are composed chiefly of gelatine, albumen, or urea.

According to our present knowledge of animal chemistry, carbon, azote, oxygen and hydrogen constitute the elementary principles of the animal body; but their binary or ternary compositions have not yet been fully investigated.

By the influence of the Vital Principle, the above elementary principles are brought into union.

Azote is largely contained in animal substances, not only in the solids, but also in the fluids; and it is found in its uncombined state in the air-bag of some fishes.

Hydrogen forms a considerable ingredient of the animal kingdom. It exists in the solids and fluids; it is generally combined with charcoal, and has been found in the intestines and stomach, in the form of carburetted hydrogen.

Oxygen forms also a share of the solids and fluids of animals. It occurs in a separate state in the air-bag of some fishes, and is often combined with carbon, forming carbonic

acid, which is contained in blood; and also in urine, and in the intestines of animals; and is emitted by expiration.

These different elements form Gelatine, Fibrine, Albumen, Extractive, Mucus, Sugar, Urea, Oils, Spermaceti, Ambergris.

Of Gelatine.—It is got from the skin, bones, muscles, ligaments and blood, by being boiled in water; it enters largely into the structure of the softest parts of the animal frame; and, when boiled to a proper consistence, forms size and glue.

Of Albumen.—It is got in the purest state, in the form of the white of an egg.

Coagulated albumen forms a large share of bones and shells; and of the greater number of the animal fluids.

Of Fibrine.—It is got from blood; the part of that fluid which has coagulated consists chiefly of it; it is white, soft and elastic, before being dried.

This substance constitutes a large share of the muscles.

Of Extractive.—It is got by boiling the flesh for some time in water, to which it gives a peculiar flavour; the gelatine and albumen remain; and if the solution be evaporated to dryness, and treated with alkohol, a solution of extractive is obtained.

Of Mucus.—It serves to protect the parts from the acrimony of their contents.

This term is applied to different secreted fluids; and hence the uncertainty which prevails as to its distinctive characters.

The mucus of the nose has been particularly examined by Berzelius *.

Of Sugar.—It exists in milk, and in the urine of diabetic persons; it may be obtained from the former, by evaporating the whey.

Of Oils.—The animal oils differ as to colour, consistence, smell, and other characters.

The greater number of these possess the properties of fix-

* *Vide* Annals of Philosophy, vol. ii. p. 380.

ed oils, being insoluble in water and alkohol; and leave a greasy stain on paper.

Oils are found in animals under the form of fat, called tallow in quadrupeds, butter, spermaceti, ambergris; hence some of the oily substances are solid, others liquid; some are white, others coloured.

There are also different earths, metals, inflammable substances, alkalies, acids, contained in the different substances, which are generated within the bodies of animals.

1*st*, Lime forms a considerable share of the bones and shells of animals, and also of the other parts; it is never found pure, but always in a state of combination with the carbonic or phosphoric acids.

2*d*, Magnesia occurs but rarely, and in very small quantities, in urine, combined with the phosphoric acid; also in some bones.

3*d*, Silica is found in a few parts of the animal frame; as in hair and urine, and urinary concretions.

4*th*, Iron has been said, by some distinguished chemists, to form the colouring principle of the blood, bile and milk; in the latter it is in a state of phosphate.

5*th*, Manganese, in the form of oxide, has been detected in the ashes of hair, by VAUQUELIN.

6*th*, Sulphur is found in a combined, but not in a simple state; it is united with oxygen, forming the sulphuric acid; it is combined with potash, and soda, and lime.

7*th*, Phosphorus is often combined with oxygen in the state of phosphoric acid, in many of the solids and fluids of animals; and the phosphoric acid is found combined with lime, ammonia, potash, and soda.

8*th*, Potash is found combined with the sulphuric, muriatic, and phosphoric acids, in small quantities.

9*th*, Soda exists in all the fluids in different states of combination. It is found combined with the carbonic, phosphoric, sulphuric, and muriatic acids.

10*th*, Ammonia is a frequent product of putrefaction.

11*th*, The fluoric acid has been found by BERZELIUS in bones and urine, and also combined with lime.

12*th*, Muriatic acid is combined with an alkali in many of the animal fluids, as with soda and ammonia in urine.

13*th*, Uric acid, or lithic acid, is found in urine and urinary calculi; likewise in the excrements of birds, reptiles, and insects.

14*th*, Lactic acid is found in many of the animal fluids, combined with soda and ammonia.

15*th*, Amniotic acid was found by VAUQUELIN in the liquor amnii of the cow.

16*th*, Formic acid is formed by infusing ants in water.

17*th*, Benzoic acid is found in the urine of children, and of cows.

18*th*, Oxalic acid is found combined with lime in urinary calculi.

19*th*, Acetic acid is found in milk, combined with potash.

20*th*, Malic acid is combined with the formic acid, in the liquor got from the red ant.

These different substances, differently combined, form the different solids and fluids of the body.

CHAP. II.

OBSERVATIONS ON THE SKELETON.

EVERY animal that is capable of progressive motion, is provided with muscles appropriated to that purpose, which are connected with some fixed point or points. The muscles of the smaller animals are fixed into the skin: thus they are enabled to creep; they can vary and maintain their form with-

out the interposition of a more unyielding substance: but those of the larger animals that move with greater velocity, that bound or leap to a considerable distance, are fixed to a hard and unyielding basis, formed of scale or bone, which serve as levers or fulcra for the muscles, and for the defence of the softer and more delicate parts of the body.

The muscles are fixed to the spine, to the scales, or to the bone, by the medium of strong, dense small cords, called *Tendons*, to which certain shut bags, or friction-wheels, or *Bursæ Mucosæ*, are appended, to prevent the bad effects of friction.

For the purpose of locomotion, there must be a number of bones, to admit of the varied and necessary movements; and the smooth surfaces of the bones forming the joints, which are applied to each other, are covered by cartilage, which is very smooth and elastic; and to avert still farther the injurious effects of friction, these cartilages are constantly besmeared by a viscid fluid called Synovia.

The bones are fixed to each other by strong membranes called Ligaments.

The whole assemblage of bones has been called the Skeleton, which sustains, gives attachment, shape, proportions, and defence, to the softer organs,—is in short the frame-work of the body.

The skeleton of some animals is external, as in the Testacea and Crustacea; and in many animals that have white blood it is an external crust or shell; but the human skeleton is internal, being covered by the softer parts; and though thus covered, the bones are seen obscurely through many of the superincumbent parts, so as to form the outline of the body.

The skeletons of animals that walk, fly, creep, or swim, bear a distant resemblance to each other: each is composed of a number of bones; and there is, for instance, a similarity between the bones of the human hand and those of the wings of bats, and those of the fins of fishes, and between the bones of the trunk of their bodies.

In the animal kingdom, there is great variety in form, disposition, number, and composition of the component bones of the skeleton of animals, which is peculiarly adapted to the peculiar economy of the animal to which it belongs. "Each class and each order of animals" (as CUVIER has well observed) "have particular characters relative to their skeleton; they consist in the general form of the trunks and extremities, in the presence or absence of the latter, and in the number of those different parts *."

Certain bones are added to the skeleton for a particular purpose. Thus the tail of the kangaroo is prolonged, that the animal may sit on it, and be assisted by it in leaping.

Animals that breathe air are provided with ribs.

In animals that breathe air in water, cartilages are superadded, on which the gills are placed.

In some animals, there are only two extremities, but in others four.

Some animals have bones peculiar to the organs of generation: a bone is found in the penis of the dog, bear, and hippopotamus.

The kangaroo and opossum are provided with bones to support the false belly.

There is a difference in regard to the size, proportions, depressions and eminences in the bones of different individuals of the same age, the same sex, and of the same country; and a still more striking variety, at different periods of life, in the different sexes, and amongst the inhabitants of different countries.

The stature of the human skeleton is various. I have seen the skeleton of a giant which measured 8 feet 2 inches in height; and there have been many instances of dwarfs that did not exceed 33 or 34 inches, though in no respect deformed; and it may not be improper to add, that there is no evidence whatever of men having degenerated in stature. I have seen many mummies that were brought from Egypt, whose average stature did not exceed 5 feet 4 or 5 inches; and have been informed

* See Ross's Translation of Cuvier's Lectures, vol. i. p. 151.

by Mr Byres, who visited many of the cemeteries at Rome, that the skeletons he saw did not exceed the size of men of this day. Deviations from the usual size are much more rare amongst the inferior animals; it is very rare to see a horse or an ox of an extraordinary size.

The proportions of the several parts of the body vary much in different individuals: much has been written upon proportions by different authors.

Audran took great pains in measuring the Greek statues, according to the rules given by Vitruvius, from the writings of the best Greek artists; but this is an investigation which is rather curious than useful, because the sculptors of Greece did not adhere to any one proportion, but varied it according to the subject to be represented. Thus, the statue of Apollo is strong, but slender; that of Mercury more athletic; and that of the Faun, though equally so, has not the same proportions, being shorter than any of the above.

The difference in the proportions of the Hercules Farnese is still more remarkable. His short neck and loins, the great breadth of the shoulders, the broad and highly arched foot, a very prominent heel, indicate great strength, but little speed or agility: whereas speed and agility are characterised by the length of the neck and loins, the length of the thighs, and by a narrower and longer foot.

The proportions of different parts of the body vary much not only in different individuals, but also at different periods of life, and in different nations.

Leonardo da Vinci, who profoundly investigated this subject, has justly said, "All the parts of any animal should correspond to its whole, viz. whatever is short and thick, ought to have all its members short and thick: that which is long and slender, should have its members long and slender: and the middle-sized should have their members of the same mediocrity." From this and other directions, it appears that when Leonardo speaks of proportions, we must understand that he reasons about agreement of the parts of an individual, rather than of a general rule of imitation respecting measures. And he has added, "It never happens, that in any species

one particular precisely resembles another: Do thou, then, the imitator of this Nature, look and attend to the variety of lineaments." Hence, according to him, the general measures of the species are of little moment. The true proportion is only the proportion of an individual respecting itself, which, according to right imitation, ought to be different in all the particulars of a species, as in nature.

Bones also vary in the constituent principles; thus some bones are harder than others: the bones of the fore-legs of deer and the race-horse are composed of hard materials.

There is little earth in the bones of cartilaginous fishes, that they may swim better.

The bones of birds are filled with air, instead of marrow; and to render the whale more buoyant, his bones are filled with oil.

Enumeration of the Bones of the Skeleton of Adults, exhibiting the Divisions, Names, and Number of Bones which compose it.

The bones of the SKELETON have been generally divided into three classes, viz. the bones of the HEAD, those of the TRUNK, and those of the EXTREMITIES.

The bones proper to the HEAD have been arranged by anatomists, into those proper to the *Cranium*, and those of the *Face*.

The bones of the CRANIUM are, 1 or 2 Ossa Frontis; 2 Ossa Parietalia; 2 Ossa Temporum; 1 Os Occipitis; Os Sphenoides,—which in the adult is joined to the preceding bone; 2 Mallei; 2 Incudes; 2 Stapedes; 2 Ossa Orbicularia; 1 Os Ethmoides.

The bones of the FACE are, 2 Ossa Maxillaria Superiora; 1 Maxilla Inferior; 2 Ossa Malarum; 2 Ossa Nasi; 2 Ossa Unguis; 2 Ossa Palati; 2 Ossa Turbinata; 2 Ossa Triangularia; 1 Vomer; 32 Teeth. The bones which support the TONGUE, are 5 in number.

The bones of the *Trunk of the Body*, are subdivided into those of the *Spine*, *Thorax*, and *Pelvis*.

The bones of the Spine and Thorax, are, 7 Vertebræ of the Neck; 12 Vertebræ of the Back; 5 Vertebræ of the loins; 24 Ribs. 2 or 3 Bones compose the Breast-Bone or Sternum.

The bones of the Pelvis are, 2 Ossa innominata*; 1 Os Sacrum. 3, 4 or 5 Ossa Coccygis; and there is in some women a small sesamoid bone, connected with the pubal portion of the Os innominatum.

The bones of the Extremities are subdivided into those of the *Upper*, and those of the *Under Extremity*.

The bones of the Upper Extremity are made up of the bones of the *Shoulders*, *Arms*, *Fore-Arms*, and *Hands*.

The bones of the Shoulders are, 2 Clavicles; 2 Scapulæ.

Bones of the Arms, 2 Humeri.

Of the Fore-Arms, 2 Ulnæ; 2 Radii.

Those of the Hands, include the bones of the *Carpi*, *Metacarpi*, and *Fingers*.

Bones of the Carpi, 2 Scaphoides; 2 Lunaria; 2 Cuneiformia; 2 Pisiformia; 2 Trapezia; 2 Trapezoides; 2 Magna; 2 Unciformia.

Of the Metacarpi, 10 Ossa Metacarpi.

Of the Fingers, 10 Posterior Phalanges; 8 Middle Phalanges; 10 Anterior Phalanges Unguium.

From 4 to 6 Ossa Sesamoidea.

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* These bones have been enumerated by some authors among the bones of the Inferior Extremities.

The bones of the INFERIOR EXTREMITIES have been subdivided into three classes; into the bones of the *Thighs*, *Legs*, and *Feet*.

Of the THIGHS, 2 Ossa Femorum.

Of the LEGS; 2 Tibiæ; 2 Fibulæ; 2 Patellæ.

The bones of the FEET have been subdivided into the bones of the *Tarsi*, *Metatarsi*, and *Toes*.

The bones of the TARSI are, 2 Astragali; 2 Ossa Calcis; 2 Ossa Navicularia; 2 Ossa Cuboidea; 2 Cuneiformia externa; 3 Cuneiformia media; 2 Cuneiformia interna.

Of the METATARSI, 10 Ossa Metatarsi.

Of the FEET, 10 Posterior Phalanges; 8 Middle Phalanges; 10 Anterior Phalanges.

The number of the SESAMOID BONES of the Feet varies from 4 to 8.

Purposes to which the Skeleton is subservient.

1*st*, The skeleton is the foundation on which the whole fabric is built. It is the basis to which all the other parts are directly or indirectly connected, and to these it gives shape, stability, and support.

2*d*, The skeleton determines the size, figure, position, proportion, and motions of the several members of the body, and regulates its attitudes.

The bones give origin and attachment to muscles, tendons, ligaments; and, in general, the eminences and depressions of the bones correspond with the strength of the muscles, and hence are much more evident in the male than in the female or infant, and in strong than in feeble animals.

These eminences remove the insertions of the muscles to a greater distance from the centre or axis of the bone, and consequently increase the force of the muscles; and those eminences in the vicinity of the joints, by adding to the length of the ligament, facilitate the movements of the joints.

3*d*, The bones of the skeleton are said to be disposed symmetrically, by which it is meant to be implied, that there is an exact correspondency of the opposite sides; for by a vertical plane from before, backward, the skeleton may be divided into two equal and similar parts. But the above observation should be received with some limitation, for in many instances the opposite bones are not exactly similar to each other, and in many cases one bone inclines more to one side than the other corresponding to it.

4*th*, The bones defend from external injury the brain, heart, lungs, and other organs, on which life more immediately depends; and also many of the larger bloodvessels and nerves in their progress; hence, by a knowledge of the bones, a surgeon becomes acquainted with their relative situation in respect to the arteries, and with the means of stopping bleeding, by pressing the arteries against the contiguous bones.

5*th*, The skeleton forms an essential part of the organs of locomotion, being an immoveable fulcrum for the action of the muscles and their tendons; hence when the bones are rendered soft by disease, we lose the power of locomotion.

The bones of the spine and extremities of the body, form solid, though flexible columns, capable of being moved in various directions.

6*th*, The extremities of the bones give form to the joints; and this connection has been termed their *articulation*.

The increased volume of the extremities of the bones tends to render the joints more secure,—is conducive to the symmetry of the limbs, the bellies of the muscles being attached to the middle parts of the bones, and the tendons to their protuberances,—increases the force of the muscles, which bend and extend the members,—prevents the risk of attrition, laceration, or compression of those muscles, or their tendons, which are necessary for the motion of the joint,—and protects from injury or pressure, during our sudden movements, or changes of curvature, the bloodvessels and nerves in the vicinity of the moveable joints.

By studying the form of the bones of the joints, we may discover what particular motion is performed by that joint; there being an exact relation between the joint and the muscles which move it: thus, there is ball and socket for admitting of a rotatory motion, and for free motion in every direction; hinge-joints, where flexion and extension only are necessary: and these joints are more or less secure in different parts of the body; thus, the socket at the hip-joint is much deeper than at the shoulder, as the inferior extremities are subservient not to locomotion only, but also to the support of the body.

The spine, which supports the head, consists of twenty-four bones, which move upon each other, and their movements determine the motions of the head and trunk of the body.

The head rotates on the second vertebra of the neck, and it is bent and extended on the atlas; but the lateral motion is divided between the whole of the joints of the seven cervical vertebræ.

The trunk of the body may be rotated or moved sideways, in which movements all the vertebræ are concerned.

The arms possess a greater range of motion than the inferior extremities, from the scapula with which they articulated being itself moveable, whereas the thigh bone is connected with the immoveable os innominatum.

When the nose is parallel to the breast bone, the face may be turned towards each shoulder through an angle of 60° on each side.

In stooping down to touch the ground, the thigh bone forms an angle of about 55° with the spine, when in its usual direction.

The leg is bent on the thigh at an angle of 15°.

The whole inferior extremity may be moved at the hip joint forwards to nearly a right angle, and backwards to an angle of 20°.

The whole arm may be moved forwards or outwards, through a half circle, and backwards to an angle of 40°. The flexion of the fore arm on the humerus is an angle of nearly 40°.

The actions of pronation and supination in the hand range through 270°, but 90° of the rotatory motion are derived from the shoulder-joint.

The palm of the hand admits of flexion and extension through 65° in each direction; its lateral motions are 35° outward and 30° inward.

The flexion of the fingers is a right angle *.

7th, From the position of the skull and pelvis, from the width of the latter, the disproportion in the length of the superior and inferior extremities, and the very different structure of the joints of these parts, it is evident that man is intended to be a biped.

8th, The bones of the human skeleton are so placed with respect to one another, that when put into their natural situation, scarcely any one of them is placed in a perpendicular bearing to another; though the fabric composed of them is so contrived, that, in an erect posture, a perpendicular line, from their common centre of gravity, falls in the middle of their common base †. On this account, we can support ourselves as firmly as if the axis of all the bones had been a straight line perpendicular to the horizon; and we have much greater quickness, ease, and strength in several of the most necessary motions we perform. It is true, indeed, that wherever the bones, on which any part of our body is sustained, decline from a straight line, the force required in the muscles, to counteract the gravity of that part, is greater than otherwise it needed to have been: But then this is effectually provided for in such places, by the number and strength of the muscles. So long, therefore as we remain in the same posture, a considerable number of muscles must be in a constant state of contraction; which we know, both from reason and experience, must soon create an uneasy sensation. This we call being weary of one posture; an inconvenience that

* Above measurements by Sir ANTHONY CARLYSLE.

† COWPER, Anat. of Human Bodies, explic. of tab. 87. 88.

we should not have had in standing erect, if the bearing of all the bones to each other had been perpendicular; but this is more than compensated by the advantages above mentioned.

9th, The disposition of the bones, and their form, have a reference to the function of the part with which they are connected. Hence the Brain and Spinal Marrow, which are very important organs, of a delicate fabric, and are injured by pressure, are contained within a bony case.—The form of the teeth and jaws, indicates the kind of food on which the animal subsists.—The senses of smell, hearing, tasting, and seeing, are much improved by the peculiar form of the bones.—The Ribs protect the organs they inclose; and their oblique position in respect to the spine, has a reference to the enlargement of the chest, during inspiration; for when the ribs are brought to a right angle with the spine, the breast-bone is pushed forwards, and the distance between the fore and back part of the chest is increased.—The Cartilages connecting the ribs to the breast-bone, being twisted during inspiration, by their elastic reaction, tend to pull down the ribs; and the breadth of the ribs protects the contents of the chest, for there is no more space between the ribs than is sufficient for lodging the muscles which raise them.—The Pelvis is of such a shape as to contain and defend many important parts, and is so formed before, that the adjacent muscles act upon the hollow bowels included within it.

10th, Broad bones are placed where defence is necessary, or where considerable space is required for the attachment of powerful muscles;—long bones where extensive motion is performed;—and short bones, where it is requisite to unite a certain degree of firmness with mobility.

Lastly, in some animals the skeleton forms a part of the organs of apprehension, as in the Lobster, Crab, &c.

CHAP. III.

OF THE BONES OF THE ADULT.

General Observations on the Bones of the Adult.

THE bones are of a white, light yellow, or light brown colour, and opaque. In the healthy state, they are hard, compact, inflexible, insensible; when dried do not change their figure; and do not, in favourable circumstances, for a great length of time, crumble into dust.

To illustrate this fact, it may not be improper to mention, that I had occasion (5th November 1819) to examine the skeleton of Robert de Bruce, who died A. D. 1350. On opening the vault, the body was found included in thin lead (which was partially oxidated), and wrapped up in an embroidered linen-cloth *. All the softer parts had disappeared, but the Skeleton was perfect, excepting a few of the smaller bones of the feet. The bones were somewhat moist, of an orange colour; and it was remarkable, that even the very thin bones of the orbit were quite entire, as also all the processes of the bones, at the base of the skull, even the pterygoid processes of the sphenoid bone, and the palate bones. The cricoid and thyroid cartilages of the larynx had been partially ossified.

The bones are covered by a membrane, named, on that account, *Periosteum*, to which the word *externum* is added, to distinguish it from a membrane which lines the bones, called *Periosteum internum.*

The internal periosteum is much thinner than the external The processes of this membrane enter into the transverse

* Vide Trans. of Society of Scottish Antiquaries, vol. ii. p. 437.

pores of the bones, where probably they are continued, to support the marrow distributed through the substance of the bones; and along with them vessels are sent, as from the external periosteum, into the bone *. These processes being of a very delicate texture, the adhesion of this membrane to the bone is so small, that it commonly separates more easily from the bone than from the marrow contained in the bone.

The bones are united to each other by ligaments, excepting the shoulder-blades, and the bones which support the tongue.

Of the Forms, Size, Situation, Prominences, and Uses of the Bones.

There is a considerable difference with regard to the magnitude, figure, situation, connection, and uses of the bones.

The bones may be arranged under three classes—the *broad*, the *cylindrical*, and those of an *irregular* figure.

Many bones have protuberances, or *processes* †, rising out of them. If a *process* stands out in a roundish ball, it is called *caput* or *head*. If the head is flattened, it obtains the appellation of *condyle*. A rough unequal protuberance is called *tuberosity*. When a *process* rises narrow, and then becomes large, the narrow or small part is named *cervix* or *neck*. Long ridges of bones are called *spines*. Such processes as terminate in a sharp point, have the general name of *coronæ* ‡, or *coronoid*, bestowed on them, though most of them receive particular names, from the resemblance they have, or are imagined to have, to other substances, *e. g. mastoid*, *styloid*, *anchoroid*, *coracoid*, *spinal*, *&c.* Such processes as form brims of cavities, are called *supercilia* §.

The eminences and depressions in the bones, are more conspicuous in the male than in the female, and generally bear a ratio to the kind of life of the individual. In men that take a

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* Winslow, Exposition anatom. des Os frais, sect. 82, 83.

† Ἀπόφυσεις, ἐκφυσεις, ἐξοχὴ, προβολὴ, πρόβλημα, Excessus, explanatio, tuberculum, gibbus, eminentia, productio, extuberantia, projectura, anascentia.

‡ Rostra, glandes.

§ Ὄφρυες, ὀφρυες, ἀμβονες, χειλὴ, Labra.

great deal of exercise, and more especially in boxers, the eminences and depressions of the bones are very conspicuous.

The thickness of the bones would seem to depend on the nourishment. Hence the natives of Australasia and Van Dieman's Land, who were ignorant as to the means of raising the necessary quantity of nourishment, were tall, but very slender. My friend Sir JOHN JAMISON sent me some years ago the skeleton of a young man, a native of New South Wales. The bones are rather smaller than those of females of the higher orders in this country: the chest and pelvis are very narrow, but they are strongly marked.

If the cavities, or depressions, are deep, with large brims, authors name them *cotylæ* *; if superficial, *glenæ* or *glenoid.* These general *classes* are again divided into several *species*: Of which *pits* are small roundish channels, sunk perpendicularly into the bone: *furrows* are long narrow canals, formed in the surface; *niches*, or *notches*, small breaches in the bone; *sinuosities*, broad but superficial depressions without brims; *fossæ*, large deep cavities, which are not equally surrounded by high brims; *sinuses*, large cavities within the substance of the bones, with small apertures; *foramina*, or holes, canals that pierce quite through the substance of the bones. When this last sort of cavity is extended any long way within a bone, the middle part retains the name of *canal*, and its ends are called *holes.*

The eminences and hollows of the bones give insertion to the muscles and ligaments, or form surfaces of articulation. Thus the insertions of the muscles are further removed from the axis of the bone, and their power of moving it thereby increased.

By the eminences to which the ligaments are fixed, these are removed to a greater distance, and greater security is given.

The cavities on the surfaces of the bones, (with the exception of the articular cavities,) are intended for the reception of

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* Κοτυλιδες, οξυβαφοι, Acetabula, pixides, buccellæ.

the muscles, or for giving passage to their tendons; thus the extent of the surface of the bone is increased, though not its bulk.

The cavities allow the heads of bones to play in them; lodge and defend other parts; and afford safe passage to vessels, muscles, &c.

Of the Colour of the Bones.

The colour of the bones depends upon the age, sex, constitution, food, the manner in which they have been prepared, and the disease which proved fatal to the animal.

The dry bones of the adult, generally speaking, are of a light straw-colour, whereas fresh bones have more of a bluish tint; owing to the number of bloodvessels which enter into their composition. The bones of animals that contain much oil, as those of the whale, are of a yellow colour; whereas the bones of dropsical persons, from which the oil and part of the marrow have been absorbed, and of those birds that are filled with air, are nearly white.

The bones of infants have a purplish tint, owing to the number of bloodvessels proper to them.

The bones of the Negro are whiter than those of the European. It is well known to anatomists, that bones which have been repeatedly washed by sea-water, and then exposed to the sun, are the whitest.

There are some substances which communicate to the bones of living animals peculiar colours. The *Rubia tinctorum*, or madder, and extract of logwood, given along with the food of the animal, alter the natnral colour of the bones: the former renders bones of a crimson colour, owing, as my late ingenious colleague Dr Rutherford discovered, to an elective attraction between the phosphate of lime of the bones, and the colouring principle of the madder *; and the latter gives them a purplish tint.

* Vide Blake's Thesis de Dentibus, p. 119. *et seq.*

The bones of some of the inferior animals are green, and of others black *.

Chemical Analysis of the Bones.

The component parts of bone are Earth, Jelly, Cartilage, and Oil. A certain proportion between these component parts is essential: if the animal-matter be superabundant, the bones are unfit for supporting the weight of the body; but if it be deficient, the bones are brittle, and are readily broken.

The quantity of earthy matter, on which the weight of the bone chiefly depends, differs much at different periods of life, and in the same man in the different bones, and in the different classes of animals, being adapted to the medium in which the animal lives.

The lightness of the bones of birds is occasioned by the large caverns within them, into which the air enters from the windpipe and lungs. The bones of most fishes contain but a very small proportion of earth, and even in whales where greater strength is required, the structure of the bones is looser than that of animals that live at land; and the internal cavities of the bones are filled with oil. Even in animals that live on land, there are large cavities in the long and cylindrical shaped bones, filled with marrow, which, while they diminish the weight, do not detract from the strength of the bones.

The constituent principles may be separated in different ways,—by burning bones in a fire,—by acids,—and by boiling.

By the aid of fire, the animal matter is driven off; and by the addition of acids, the earthy matter is dissolved, and may be readily precipitated by the addition of an alkali.

The earthy matter contained in human bones consists of the Phosphate of Lime, of Carbonate of Lime, and of a very small proportion of the Sulphate of Lime.

In the bones of quadrupeds, a small proportion of the phosphate of magnesia, iron, silex, and alumina, has also been detected by Fourcroy and Vauquelin; and Berzelius has stated, that from human bones he has obtained 2 *per cent.* of fluate of lime.

* Vide Blumenbach's Comparative Anatomy, by Lawrence.

The oil and jelly of the bones may be readily obtained by boiling; the former swims on the surface, and the water dissolves the jelly.

When bones have been boiled for some time, and deprived of their jelly, and of their earthy matter, by being immersed in an acid, a soft greyish-coloured cartilage remains, retaining the figure of the bone, which, according to Mr Hatchett *, the discoverer of this substance in bones, is similar in its properties to coagulated albumen.

Several of the modern chemists have analysed bones, more especially Hatchett, Fourcroy, Vauquelin, Cadet de Vaux, and Merat Guillot; but their researches have been limited chiefly to the examination of the bones of quadrupeds, and few experiments have been made upon human bones, either in their sound or diseased state. In these circumstances, some years ago, I requested of my friend Dr John Davy, whose chemical knowledge is well known to the public, to analyse the bones of persons of different ages, in their sound and diseased state; with which request he readily complied, and has favoured me with the following results.

"I have carefully examined the different specimens of bones you gave me. The experiments I have made on them were few, want of leisure not allowing me to be minute. I have tried them respectively with dilute muriatic acid, and have found all of them similarly acted on. They effervesced slightly; yielded a cartilaginous residue, and their solutions afforded a precipitate with ammonia. The only apparent difference was in respect to the degree of effervescence. The reticular bones effervesced more briskly than the firm and compact ones. But this appeared to be principally owing to the greater extent of surface exposed to the acid by the former, than by the latter: for I obtained from 50 grains of the rickety parietal bone 2 grains of carbonate of lime, just the proportion found by Mr Pepys in human teeth.

"I have only attempted to ascertain the proportions of earth and of animal matter. To effect this, I exposed a cer-

* Vide Lond. Phil. Trans.

tain quantity of each bone separately, in an open crucible, to a red heat, till it was rendered white, or perfectly free from carbonaceous matter, internally as well as externally. For the sake of greater accuracy, the pieces of bones made the subjects of experiment were loosely wrapped up in a thin sheet of platinum. Thus the admixture of dust from the fire was excluded.

" I shall give the results in the following Tables.

I.—*Human Bones apparently in a Sound State.*

100 Parts consist of	Animal Matter.	Earth.
Pars petrosa of the temporal bone of an adult,	33.3	66.7
Temporal bone of the same under the zygomatic process,	34.7	65.3
Occipital bone of the same,	40.0	60.0
A part of the lower jaw of the same, between the symphysis and processes,	40.5	59.5
The parietal bone of another adult,	35.6	64.4
Another parietal bone of an adult,	37.5	62.5
The body of the tibia of an adult,	36.0	64.0
The body of the thigh-bone of an adult,	37.5	62.5
The occipital bone of an old man,	31.0	69
A part of the lower jaw of an old person, between the symphysis and processes; the alveoli were absorbed; the bone brittle,	43.4	56.6
Lower jaw of a child,	42 8	57.2
The occipital bone of a negro; very hard, compact, and white,	40.5	59.5
The occipital bone of another adult negro, hard, compact, and white, but not in so great a degree as the former,	41.1	58.9
Occipital bone of a subject of about fifteen years of age, of the usual appearance,	42	58
Frontal bone of the same subject,	41.1	58.9
Parietal bone of the same subject,	41.2	58.8
Tibia of the same subject,	46.4	53.6
Fibula of the same subject,	56	44
Os Ilium of the same subject,	55	45
Thigh-bone of the same subject,	53	47
Frontal bone of a child, the bregma still remaining,	45.5	54.5
Parietal bone of the same skull,	46	54

II.—*Human Bones in a Diseased State.*

100 Parts consist of	Animal Matter.	Earth.
The body of a large thigh-bone of an adult affected by hyperostosis; very thick and hard, but not very compact,	23.1	76.9
The bone of a person who died of lues venerea; thick, light, and spongy in a slight degree,	29.26	70 74
Cancelli of a curved tibia,	25.5	74.5
The compact body of the same bone,	37.0	63.3
A rickety parietal bone, about an inch thick,	27.1	72.9
Another portion of the same bone, similar in appearance,	30.5	69.5
The body of a rickety thigh-bone; very thick,	37.8	62.2
An exostosis,	36.2	63.8
A scrofulous exostosis,	37.0	63.0
A spinal process of a lumbar vertebra of the curved spine of a rickety person,	40.7	59.3
A rib of the same person,	40.8	59.2
The tibia of a rickety child; soft and spongy,	74.0	26.0
A deformed female pelvis: soft and porous, and not unlike horn in appearance,	75.8	24.2
Portion of bone cast off in the disease called Necrosis ossium,	40.8	59.2

III.—*Fossil Bones, and Bones of different Animals.*

100 Parts consist of	Animal Matter.	Earth.
Frontal Roman bone found at Pompeia; thick, and not unlike the rickety parietal bone,	35.5	64.5
Bone found at Borrowstounness included in sandstone; apparently a human tibia,	16.8	83.2
Bones from the banks of Ohio, reddened by oxide of iron, and penetrated by extraneous earthy matter. These bones were brought to this country by Mr Ashe, who said he had found them at the depth of 12 feet,	31	69
A tooth of the mammoth,	30.5	69.5
The enamel of the same tooth,	17.4	82.6

III.—*Continued.*

100 Parts consist of	Animal Matter.	Earth.
Pars petrosa of the temporal bone of a whale,	27.4	72.6
Pars petrosa of the temporal bone of an elephant,	30.0	70.0
The perpendicular lamellæ of the vertebra of the large animal found on the shore of the Island of Stronsa *, ...	44.5	55.5
The internal cellular lamellar part of the same, penetrated by small foramina, . .	52	47.9
The fibrous part of the texture, having the appearance of willow, forming the cavity of the same vertebra, ...	60.0	40.0

" *Observations.*—The loss which the different bones sustained by calcination, is considered as the proportion of animal matter entering into their composition. This method of forming the estimate, though not perfectly accurate, is yet certainly near the truth, and apparently well adapted for comparative purposes.

" The results contained in the different tables vary so much that they scarcely admit of any general conclusions being drawn from them.

" Between the diseased bones there is the greatest difference of the proportions of the constituent parts. Some of the bones marked rickety, *contain more, and some less, earth, than the same bones in their healthy state.*—The latter, it may be conjectured, belonged to the disease in its early stage; and the former to a stage of convalescence or recovery.

" The results of the 1st Table shew, that the proportions of earth and of animal matter vary in different healthy bones of the same person, and in the similar bones of different persons; that in old age, the phosphate of lime apparently increases in quantity in the occipital, and diminishes in the jaw

* Vide Description of this Animal, Memoirs of the Wernerian Natural History Society, vol. i.

bones; that the composition of the sequestra is much the same as that of sound bones; and it further appears from these results, that the hardness of bones in general is not *always* proportional to the quantity of earth present, though in the same skeleton this probably is the case; and, lastly, the concordance of composition of two Negro skulls, both remarkably hard and white, renders it probable that the bones of Africans will be found to contain a larger proportion of animal matter than the bones of Europeans.

"Respecting the bones placed in the table after the Negroes, it is necessary to observe, that they were examined but a day or two after they were taken from the subject to which they belonged, and had not been cleaned, as bones usually are that are designed to be preserved. There was consequently no deficiency of the animal *fluid* peculiar to them. This circumstance accounts for the much smaller proportion of earth in these than in the preceding sound bones. The bones of the lower extremity appeared to be saturated with this fluid; those of the head seemed almost entirely free from it; hence, too, the much smaller proportion of earth in the former than in the latter.

"It is worthy of remark, that the fibrous part of the vertebra, in the last table, was very flexible, notwithstanding the considerable proportion of phosphate of lime present. It may be proper, also, to notice, that the enamel of the tooth of the mammoth was of singular hardness, sufficiently hard, indeed, to scratch glass; and yet, when deprived of its animal matter, of its cement, by calcination, it was more friable than any of the other bones. I endeavoured to ascertain if this enamel contained fluoric acid, but I could not detect its presence.

"To conclude, if the preceding results do not allow any very satisfactory general conclusion to be formed from them, they at least seem to shew, that inferences were, in former cases, too hastily drawn, and that further investigation of the subject is necessary."

It may not be improper to mention, that bones and shells bear a strong resemblance to each other, as to their chemical in-

gredients, as Mr HATCHETT has well observed in the following sentence: "Bone, shell, coral and the zoophytes, only differ in composition, by the nature and quantity of the hardening or ossifying principle, and by the state of the substance with which it is mixed or connected: for the gluten or jelly which cements the particles of the carbonate or phosphate of lime, and the membrane, cartilage, or horny substance, which serves as a basis, in and upon which the ossifying matter is secreted and deposited, seem to be only modifications of the same substance, which progressively graduates from a viscid liquid or gluten, into that gelatinous substance which, by increased inspissation, and by the various and more or less perfect degrees of organic arrangement, forms the varieties of membrane, cartilage and horn."

Of the Periosteum.—All the bones, excepting the bodies of the teeth, are covered by a compact, tough, whitish coloured serous membrane called *Periosteum*, and which is of different thickness in different places.

This membrane is externally rough, and covered by a quantity of cellular substance, by which it is fixed to the neighbouring parts, but internally smooth; and it is fixed firmly to the surfaces of the bones by short cellular threads, and by a great many small bloodvessels, which, on tearing this membrane from the bone, discharge blood.

A membrane, similar to this, covers the cartilages, which has been called *Perichondrium.* The periosteum may be divided into two layers. The fibres of the outer layer vary in their size, number and direction, in different bones, and even in the same bone in different places.

The internal layer is similarly constructed as the external, but the fibres composing it are smaller, and have rather more of a glistening appearance, and follow the same course as those of the bone to which they are fixed.

Arteries derived from the neighbouring arteries, are distributed into very small branches upon this membrane, before entering into the substance of the bones; and are larger and more numerous than those of tendons or ligaments; and

where bone is growing, the bloodvessels of this membrane are very numerous.

The veins corresponding with these arteries may sometimes be seen in subjects that die full of blood.

This membrane has also its nerves.

In the healthy state, it possesses but little sensibility, but when under the influence of inflammation, as in deep seated paronychia, or when stretched by nodes growing from the subjacent bones, the patient suffers excruciating pain, which is often relieved by dividing it freely.

Lymphatic vessels are also proper to the periosteum; by disease it attains, in some cases, an unnatural thickness, and, in process of time, regains its natural thinness, which can be the result only of the action of the lymphatic vessels.

The periosteum is subservient to several very important uses. 1*st*, To assist in the formation of bones.

2*d*, To support the vessels in their passage to the bones.

3*d*, To strengthen the conjunction of the bones with their epiphyses, ligaments and cartilages, which are easily separated in young creatures, when this membrane is taken away.

4*th*, To afford convenient origin and insertion to several muscles, which are fixed to this membrane.

5*th*, By means of the periosteum, the muscles, when they contract, or are stretched, move and slide easily upon the bones; whereby the effect of friction is averted.

The intimate Structure of Bones.

Bones are composed of a great many *plates* *, which are obvious, by very long boiling, and in bones that have been long exposed to the weather, and also in some of the diseases of bones;—and each of the layers is made up of fibres united by smaller fibrils; which being irregularly disposed and interwoven with the other large fibres, make a reticular work †.

The plates are said ‡ to be firmly joined to each other by

* Squamæ, bracteæ, laminæ.

† Malpigh. Anat. plant. & oper. posthum.

‡ Gagliard. Anat. Ossium, nov. invent. illustrat. cap. 1. obs. 2.

a great number of *claviculi*, or small bony processes, which, rising from the inner plates, pierce through some, and are fixed into the more external ones. Of these nails, four kinds, viz. the *perpendicular*, *oblique*, *headed* and *crooked*, have been described: But in bones properly prepared, we can see only numerous irregular processes rising out from the plates *; so that we are not to imagine that the lamellæ are fixed to each other by nails, there being merely an intermixture to a certain degree of the constituent fibres of the bone.

Bones are more or less cavernous internally, for the sake of lightness. In some (*e. g.* middle thin part of the scapula and os ilium) the solid sides are brought so near that little cavity can be seen; and in others (middle of os humeri, femoris, &c.) the cavities are so large that such bones are generally esteemed to be hollow. The internal spongy texture is evident in young animals; and sometimes it is found in those of the oldest people.

This spongy cavernous internal part of bones is formed by layers detached from the inner surfaces of the bones, which are interwoven with those of the opposite side of the bone. As the cells are most numerous at the extremities of the bones, the solid walls or sides are not thicker than paper; but the solid walls are thicker at the middle part of the bone, there being fewer cells in that situation.

These cancelli differ considerably in figure, number and size; and communicate with each other. Some writers † have described differences in the appearance of the cancelli; and from thence distinguish them into *wrinkled*, *perforated* and *net-like*.

The cancelli sustain the marrow, and prevent one part of it from compressing another. The depressions between the fibres of the external plates of bones appear like so many furrows on their surface, by which the surface of contact, and con-

* Malpigh. Oper. Posthum.

† Gagliard. Anat. Ossium, cap. 1. obs. 4, 5, 6, 7.

sequently the adhesion between it and the bones, is increased, and a greater number of vessels is sent from it into the bone, than if it were a plain surface.

The *broad* bones have thin sides, by the plates being soon and equally sent off to form the lattice-work; which therefore is thicker, and nearly of an equal form all through. By this structure, they are well adapted to their uses of affording a surface large enough for the muscles to rise from, and move upon, and of defending sufficiently the parts which they cover.

The walls of the *round* bones are thick in the middle, but very thin towards their ends, owing to very few plates separating at their middle; and, on that account, the cancelli are so fine and small, that they are not taken notice of.

Towards their ends, the lattice-work becomes very thick, and rather more complete than in the other sort of bones.

The round shaped bones have thick sides towards their middle, where the greatest forces are frequently applied; while their hollowness increases their diameter, and consequently their strength to resist forces applied to break them transversely *. Thus, for instance, in estimating the proportional resistance of two cylindrical bones of unequal diameters, but consisting of an equal number of similar fibres uniformly disposed round each, it is plain,

1*st*, That the absolute force of these two bones is equal, because they consist of equal numbers of similar fibres.

2*d*, That the absolute forces of all the fibres in each bone have the same effect in resisting any power applied to bend and to break them, as if the sum of all their forces were united in the respective centres of the transverse sections, where the fractures are to be made. For, by hypothesis, the fibres being uniformly disposed in each, there is not any fibre in either bone that has not a corresponding fibre; the sum of both whose distances from the axis of revolution (about which all the parts of the bone must revolve in breaking) is equal to two semidiameters of the bone: Consequently each fibre,

* Galilei Mechanic. dialog. 2.

and all the fibres, may be regarded as resisting at the distance of one semidiameter or radius from this axis, that is, in the centre.

3d, Since the united force of all the fibres is to be regarded as resisting at a distance from the centre of motion equal to the semidiameter, it follows, that the total resistance of all these fibres, or the strength of the bone, is proportional to its semidiameter, and consequently to its diameter.

I have here taken for an example, one of the most simple cases for calculating the proportional strength of bones. But, were it not too foreign to the present design, it might be easily demonstrated, that, of whatever figure bones are, and in whatever manner their fibres are disposed, their strength must always be in a ratio, compounded of the area of their transverse sections, or of their quantity of bony matter, and of the distance of the centre of gravity of these sections, from the centre of motion, or fulcrum on which the bone is supposed to turn when broken *.

Since, therefore, the strength of bones depends on their number of fibres, or quantity of matter, and the largeness of their diameters, we may conclude, that the part of a bone formerly fractured, and reunited by a callus, must be stronger than it was before the fracture happened; because both these advantages are obtained by a callus.

It may not be improper to add, that although a bone from being hollow resists, in a greater degree, such forces as tend to break it transversely, because the corresponding fibres are at a greater distance from the immoveable centre on which they turn, and therefore resist more, from their gaining the advantage of a longer lever; yet we are to observe, that where a bone is pressed in, as by the wheel of a cart, or beat in by the stroke of a stone, or of a bullet, its resistance is lessened by its hollowness, because the impelling force acts with the advantage of a longer lever. Thus, a small glass phial is perhaps strong enough to support a man's weight, but a larger

* See the demonstration of this theorem by Dr Porterfield in the Edinburgh Medical Essays, vol. i. art. 10.

phial of the same thickness will be broken by it. Hence also, if two skulls be of the same thickness, but unequal in size, the larger is more easily fractured.

In consequence of the bones being hollow, they are much lighter than if they had been solid; much larger and stronger muscles would have been required to move the bones, and this would have been attended with another disadvantage, the animal must have been larger, and must have been supplied with more blood.

Of the Marrow.

The marrow, which differs in appearance in different bones, is secreted by the small arteries which are distributed upon the follicles which contain it. These arteries are very small, and not obvious to our unassisted senses.

Pure marrow, according to Berzelius, is a species of fixed oil, possessing peculiar properties, and somewhat like butter. It consists of the following ingredients:

Pure marrow, - -	0.96
Skins and bloodvessels, -	0.01
Albumen, Gelatine, Extractive, Peculiar matter,	0.03
Water, - - -	1.03

There is at least one considerable artery proper to each bone; several bones have more. These arteries, after piercing the solid side of a bone, are divided into several branches; which are distributed on the internal periosteum, and on the medullary cells, and then pass outwards through the tables of the bone.

The blood, which remains after the secretion of the marrow, is returned by large veins formed by the junction of the smaller veins, and which pass out at the same holes in the bones as the arteries enter.

The membrane of the marrow is probably sensible, though

Baron HALLER was led by his experiments to consider it to be destitute of sensibility, an opinion he adopted from its similarity to the subcutaneous fat. But correct conclusions cannot, in all cases, be drawn from analogy; for DU VERNEY, an accurate observer, after amputating the leg of a dog, thrust the instrument into the marrow, which seemed to give the animal "un très vive douleur."

On the internal surface of the solid parts of bones, there are, according to HAVERS, orifices of canals, which pass outwards through the plates to open into other canals that are in a longitudinal direction, from which other *transverse* passages go out to terminate in other *longitudinal* canals; and this structure is continued through the whole substance of bones, both these kinds of canals becoming smaller gradually as they approach the outer surface *. These canals are most conspicuous in a bone burnt till it is white: When it is broken transversely, the orifices of the longitudinal canals are in view; and when we separate the plates, also the transverse canals.

Different opinions have been held respecting the use of the marrow: 1*st*, It is not necessary to perfect health, as birds and cartilaginous fishes, that are destitute of it, are as healthy as other animals. 2*d*, It does not render the bones less brittle; for those of the fœtus, which contain little marrow, are not more brittle than those of the adult which contain a much greater quantity of it, and the bones of old persons, in whom the medullary canal is very large, are more brittle than those of persons in the meridian of life.

Nor are the bones of the cetacea or of the tortoise that are destitute of marrow more brittle than those of other animals.

It is evident that the marrow is not more essential than fat, as many animals are quite healthy without fat or marrow.

Of the Nerves of Bones.

A bone is a living organized substance, having its proper nerves, bloodvessels and absorbents.

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* HAVER's Osteolog. nov. p. 43.

The bones in their healthy state possess but a small share of sensibility; they may be sawn or cut without creating much pain.

The nerves proper to the bones are but of small size, excepting those of the teeth, which, as my Father has observed in his book upon the Nerves, are very large in proportion to the size of the teeth.

If sensibility is a proof of nerves entering into the composition of any part, we have sufficient evidence of nerves being proper to the bones; for the granulated red flesh which sprouts out from them, after an amputation of a limb, or performing the operation of the trepan, or after an exfoliation, is exquisitely sensible; and, in some ulcers of bones, where the periosteum was separated, the patient suffered acute pain, if the bone was touched with a rough instrument; nor was he free of pain after the bone was perforated.

The granulated flesh which sprouts from the bones after amputation, or after an exfoliation, is extremely sensible.

Ulceration of the bones is attended with very acute pain.

Of the Bloodvessels of Bones.

The bloodvessels proper to bones enter their surfaces from the periosteum or by separate foramina.

The bloodvessels of the bones are much more numerous than we should expect from their colour, for the earth of the bone conceals them; and hence they are not apparent, after being filled by a red injection, until the earth of the bone has been destroyed by steeping it in the nitric or muriatic acids. When a bone, thus prepared, is put into oil of turpentine, its vessels are quite obvious.

The arteries of the bones may be traced in their course from the pits to the plates and fibres of the bones, and in sawing, cutting, or rasping the bones of a living animal, drops of blood are discharged, even from the most solid parts of the bones. That a great number of arteries enter into the composition of the bones is obvious, from the effect of madder given along with the food of animals, which gradually communicates its tinge to every part of the bone.

The arteries are larger near each end than at the middle of the large bones, because they are not only distributed upon the bony plates near the ends, but pass through them to the marrow.

There are many more bloodvessels in the bone of a young man than in those of an old, and especially in that part which is in a state of growth.

There are also branches of the medullary artery, which anastomose with the arteries above named; hence, by a fracture no part of the bone is deprived of blood; hence, also, when suppuration takes place within bones, though the cancelli of the bone and marrow are destroyed, the bone still continues to live.

The arteries of bones have their corresponding veins.

Lymphatic Vessels of Bones.

We cannot trace these vessels into the substance of the bones.

From what has been said of the vessels of bones, it is evident, that there is a constant circulation of fluids in every part of them; and that there is a perpetual waste and renewal of the particles which compose the solid fibres of bones, as well as of other parts of the body; the addition from the fluids exceeding the waste during the growth of the bones; the renewal and waste keeping pretty near *par* in adult middle age; and the waste exceeding the supply in old age; as is demonstrable from their weight. For each bone increases in weight as a person approaches to maturity; continues of nearly the same weight till old age begins, and then becomes lighter. The specific gravity of the solid sides, on the contrary, increases by age, for then they become more hard, compact and dense.

In consequence of this, the bones of old people are thinner and firmer in their sides, and have larger cavities than those of younger persons.

That lymphatic vessels are proper to bones is obvious, from the phenomena which take place during the formation of bone; from the red colour which is communicated to bones

by feeding animals with madder, being removed; and from the effect of unnatural pressure on bones, and of remedies in removing their diseases; and also, from the swelling of the glands connected with the lymphatic system, which is the concomitant of many diseases of the bones.

My Father was, I believe, the author of the doctrine of the absorption of bones, and the other solid parts of the body.

He made mention of this doctrine in his lectures, according to his statement, since the year 1759; whereas, according to Sir E. Home, "Mr John Hunter's Observations on the Growth of Bones have been mentioned in his lectures only since the year 1772,—the first year in which he gave lectures."

Upon the above principle my Father endeavoured to explain the disappearance of the upper part of the breast-bone in cases of aneurism of the arch of the aorta, which Dr William Hunter imputed to a solvent power of the blood: "But in this case," (he has observed) "the appearance was rather as if the blood had insensibly dissolved, and washed away the substance of the bone, making greatest havoc in the softest part of the bone, as we see in stones of unequal texture that have been long washed by a dropping, or a stream of water. Has the blood that property, which some have ascribed to it, of dissolving bony matter?"

It is plain, then, either that Mr John Hunter had not, at that time, proposed the doctrine of the Absorption of Osseous Matter; or, if he did so, that his brother was ignorant of it, or paid no regard to it.

CHAP. IV.

OF THE ARTICULATIONS.

THE Articulations are most commonly divided into three classes, viz. Symphisis, Synarthrosis, and Diarthrosis.

Symphisis, which properly signifies the concretion, or growing together, of parts, when used to express the articulation of bones, does not seem to comprehend, under the meaning generally given to it, any thing relating to the form or motion of the conjoined bones, but by it most authors generally denote the bones to be connected by some other substance; and as there are different substances which serve this purpose, therefore, they divide it into the three following species.

1*st*, *Synchondrosis*, When a cartilage is the connecting medium; thus the ribs are joined to the sternum; the bodies of the vertebræ to each other; as are likewise the ossa pubis.

2*d*, *Syneurosis*, or *syndesmosis*, When ligaments are the connecting bodies, as they are in all the moveable articulations.

3*d*, *Syssarcosis*, When muscles are stretched from one bone to another, without the intervention of cartilage or ligament.

The *second* class of articulations, the synarthrosis, which is the general term by which the immoveable conjunction of bones is expressed, is divided into three kinds:

1*st*, The *Suture* * is that articulation where two bones are mutually indented into each other, and is formed by the fibres of two bones meeting, while they are yet flexible and yielding, and have not come to the full extent of growth. These indentations are very different, both in figure and magnitude: Thus the bones of the head are joined; thus epiphyses are joined to the bones, before their full connection and union with them.

Under this title of *suture*, the *harmonia* of the ancients may be comprehended; scarcely any immoveable bones being joined by plain surfaces †.

2*d*, *Gomphosis* ‡, is the fixing one bone into another, as a nail is fixed in a board: Thus the teeth are secured in their sockets.

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* Ῥαφη. † Vesal. Observ. Fallop. Examen.

‡ Conclavatio.

3d, *Schindylesis* or *ploughing* *, when a thin lamella of one bone is received into a long narrow furrow of another: Thus the processus azygos of the sphenoid, and the nasal process of the ethmoid bone, are received by the vomer.

The *third* class, or DIARTHROSIS †, is the articulation where the bones are so loosely connected as to allow large motion. This is subdivided into three kinds:

The first is *enarthrosis*, or the ball and socket, when a large head is received into a deep cavity; as the head of the os femoris is into the acetabulum coxendicis.

The second is *arthrodia*, when a round head is received into a superficial cavity; as in the articulation of the arm-bone and scapula. These two species of diarthrosis allow motion to all sides.

The third is *ginglimus* ‡, which properly signifies the hinge of a door or window. In it the parts of the bones mutually receive, and are received, and allow of motion two ways: Workmen call it *charnel*.

The ginglimus is generally divided into three kinds, the *contiguous* ||, *distant* §, and *compound* ¶.

The first kind of ginglimus is, when a bone has several protuberances and cavities, corresponding to as many cavities and processes of the other bone with which it is articulated; as in the conjunction of the femur with the tibia.

The second species is, when a bone receives another at one end, and is received by the same bone at the other end; as in the radius and ulna.

The last sort is, when a bone receives another, and is received by a third; as the oblique processes of the vertebræ.

But though the preceding account of the *diarthrosis*, or articulation of moveable bones, has been almost universally received; yet, seeing it does not comprehend all the moveable

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* KEIL, Anat. chap. 5. § 3.

† Απαρθρώσις, dearticulatio, abarticulatio.

‡ Articulatio mutua. || Proximus.

§ Longus. ¶ Compositus.

articulations of the body, and one of its species does not answer to any notion we can have of the conjunction of two bones, I must beg leave to change the definitions and kinds of these joints.

The *diarthrosis* is that conjunction of bones, whereby they are fitted for motion, being each covered with a smooth cartilage, connected by one or more common ligaments, and lubricated with liquor at the conjoined parts. In which definition, I pay no regard to the quantity of motion which they really do perform; the motion being often confined or enlarged by some other cause not immediately depending on the frame of the two surfaces of the bones forming the particular joint in question.

The first species of the diarthrosis, *viz.* the *enarthrosis* or ball and socket, may be defined more generally than above:— That articulation where a round head of one bone is received into a cavity of another, and consequently, without some foreign impediment, is capable of motion to all sides. The articulation of the thigh-bone and ossa innominata; Arm-bone and scapula; astragalus and os naviculare; magnum of the wrist, with the scaphoides and lunare; the metacarpal and metatarsal bones with the first bones of the fingers and toes, &c. are examples of this kind of joint.

The second sort, or the *arthrodia*, differing from the enarthrosis, described above, only in the cavity being more superficial, which makes no essential difference, especially as, in the recent subject, cartilages or ligaments supply the deficiency of bone, ought, in my opinion, to be called, with Vesalius, that articulation of two bones adapted for motion, where it is not at first sight obvious which of the two has the head or cavity, or where they are joined by plain surfaces, or nearly so; such as the conjunction of the clavicle with the scapula; ossa cuneiformia with the os naviculare; metatarsal bones with the ossa cuneiformia, &c. From the nature of this sort of joint, it is plain, that very great motion cannot be allowed, without the bones going farther out of their natural situation, than is convenient or safe.

CHAP. V.

OF FŒTAL BONES.

BONES do not enter into the original composition of the human frame. Upon examining a very young fœtus, we observe that it is composed chiefly of a membranous or cartilaginous substance, which has nearly the same form as the bone, and upon this basis a number of bloodvessels may be observed after a successful injection of the bloodvessels, which are much enlarged where ossification commences. Upon examining with attention what takes place in the earlier stages of ossification, we observe small grains, connected with the arteries of the part, deposited in an irregular manner: these are gradually united, so as to form fine fibres; which fibres are disposed differently in different bones, and become more numerous, and being crossed by smaller fibres, form a sort of net-work. The fibres are more numerous and more closely compacted towards the middle of the bones: hence a centre or centres of ossification have been described. These appearances may be observed, not only in the healthy, but also in the diseased state of the bones; in the latter, they are more conspicuous, as being carried on upon a larger scale, as in cases of hydrocephalus chronicus, exostoses, necroses, ossification of the dura mater, and also in the process of the re-union of fractured bones. After a time, the fibrous appearance is by no means obvious, the interstices between the fibres being in the progress of ossification filled up.

The process of ossification is more rapid, and is sooner completed in quadrupeds and birds, than in man; whereas in other animals, as in the whale and alligator, it goes on during the whole of life. It merits, however, particular mention, that even the process of ossification does not go on with equal

rapidity in every part of the skeleton; thus the ribs are converted into bone at a very early period, in order to prevent the action of the heart from being impeded by the pressure of the superincumbent parts. This fact is also clearly elucidated by the time necessary for the re-union of the different bones: thus those of the superior extremities are more speedily reunited than those of the inferior; much, however, depends on the age, constitution, extent of the injury, and mode of treatment. In different bones there is a greater or less number of white spots or centres of ossification, as in those of the skull, from which the fibres diverge. In the long bones of a cylindrical shape, there are central rings, from which the fibres extend upwards and downwards. In cases of exostoses, the new formed bone is sometimes distributed through the cartilage in an arborescent form.

To far the greater number of bones, whose ends are not joined to other bones by an immoveable articulation, there are smaller ones annexed, which afterwards become scarce distinguishable from the substance of the bone itself. These are called *Epiphyses*, or *Appendices* *. Some bones have one, others have two, three or four of these appendices annexed by the means of cartilages, which are of a considerable thickness in children, but by age become thinner; the ossification proceeding from the end of the bone on one side, and from the epiphyses on the other, till at last, in adults, the place of their conjunction can scarcely be seen on the external surface; and it is only sometimes that we can then see any mark of distinction in the cancelli.

Several processes (*e. g.* trochanters of the thigh, spine of the scapula, &c.) have epiphyses; and processes frequently rise out from epiphyses; for example at the lower end of the femur, ulna, tibia, &c.

The epiphyses are united chiefly to such bones as are destined for frequent and violent motion; and for this purpose they are of a larger diameter than the bone they belong to: thus the surface of contact between the two bones of any articula-

* Applantatio, additamentum, adnascentia, adnexum, perone.

tion being increased, their conjunction becomes firmer, and the muscles inserted into them act with greater force, by reason of their axes being further removed from the centre of motion. By means of epiphyses, the body is rendered more flexible, and the body of the child is better adapted to the form of the mother's womb, and the ossification is sooner completed.

Of the Formation of Bone.

The most important circumstances respecting the formation of bone may be comprehended under the following heads.

1*st*, What is the nidus in and upon which bone is deposited? and what change is produced in that nidus after bony matter has been deposited?

2*d*, Is bony matter contained in the blood; and whether is this deposited in a solid state, or held in solution?

3*d*, What happens just before, and while the process is going on?

4*th*, Whether is bone derived from the vessels of the periosteum, or from those proper to the substance of the bones?

5*th*, At what time does the ossification of the different bones of the fœtus take place?

6*th*, Are there any causes which accelerate or retard the process of ossification?

The older anatomists in order to detect the earlier stages of the process of ossification, and the manner in which ossification is carried on, examined with great care young fœtuses; but on account of the extreme similarity in the colour of the membranes and gristles, and the bony particles, it is impossible to discriminate the one of these substances from another. Much more accurate information may be obtained, by examining the mode in which fractured bones are united, or by feeding an animal with madder, which communicates, from the elective attraction between the colouring part of it and the phosphate of lime, a reddish tinge to the bone, and hence the smallest particle of bone becomes visible as soon as it is formed.

According to Dr Boerhaave, when ossification is about to take place, the lymph of the blood is effused, which lymph has a determined shape, and is covered by a membrane.

Dr Macdonald's experiments led him to suppose, that pure blood is effused between the broken ends of the bones, from which the red globules are in a short time abstracted.

This coagulated blood or incipient callus, in a short time becomes vascular, and is covered by a newly formed periosteum, which adheres to the original one, after which the ossification commences. But the breaking the bones at the commencement of the experiment, by which many bloodvessels must have burst, seemed to me to render it impossible to determine, whether the effusion of red blood was the preliminary step. I therefore directed my attention to that remarkable disorder, the hydrocephalus chronicus, in which the bones of the skull, in consequence of the increased volume of the brain, are kept growing for a number of years.

In consequence of having examined a number of instances in which bone was forming, I am led to believe, that the process of the new formation of bone is as follows:—Blood is effused, the red particles of which are speedily absorbed, together with the serum. The fibrine which remains, forms a sort of nidus, in which the bony matter is deposited: whilst this process is taking place, the bloodvessels of the part are very much enlarged. The bony matter is not deposited in a solid form: it is probably held in solution by the phosphoric acid, which acid is afterwards abstracted by the absorbent vessels. When the bony substance which has been recently formed has been dried, it is very white, and so soft that it may be scratched by the nail, and exhibits a granular surface, but which, after a short time, it loses (in consequence of the filling up of the interstitial spaces), and becomes quite smooth. It merits particular notice, that these small grains, which constitute as it were the bases of the bones, are not always of the same size.

Dr Dunlap, a favourite pupil of Sir Astley Cooper's, last season (1823), published in his Thesis the result of the observations of his preceptor on this head:

"Quando os simpliciter fractum fuit, sanguis inter extremas partes ejus effunditur; verum is sanguis nihil confert, uti olim existimatum est, in osse resarciendo, sed circiter quartum

diem post casum absorbetur. Quæritur quidem an integer sanguis, an rubræ particulæ solum ejus (ut putat Cl. Doctor Monro tertius) absorbeantur, ita ut fibrina ejus albumenque supersint? Utcunque vero hoc sit, accedit inflammatio circa partes fractas ossis, periosteumque ab osse disjungitur. Hæc inflammatio posteaquam ad sex dies persteterit, effusio cartilaginis sive firmæ lymphæ coagulabilis fit, semperque a parte interiore periostei; quæ primum exigua copia, deinde multo majore facta, ossi periosteoque adhæret. Quod si talis fractura est, ut fractæ partes ossis transverse quasi contingant inter se, tum hæc inflammatio accidit maxime in extremis partibus: sin vero oblique os fractum fuerit, tum maxime in iis partibus quæ ita inter se committuntur, ut altera in alteram quasi dilabatur. Hæc materia cartilaginosa, in cuniculis similibusque bestiolis, per novem decemve dies post fracturam effunditur; in homine vero longe diutius, peneque ad vigesimum diem fertur. Hujus autem copia ut adaugetur, periosteum sensim ab osse detrudit; quod ita comprimitur, ut post spatium aliquod absorbeatur, cartilaginesque inter se coëant. Hoc ubi accidit, particulæ ossis in cartilagine deponuntur, quæ gradatim inter se adhærent, et tandem fractas partes ossis conglutinant; prout autem os increscit, cartilago absorbetur, donec prius, post aliquamdiu, spatium posterioris ex toto impleat."

Mr Howship * has concluded from his observations, that in the mammalia, the first rudiments of ossification in the long bones are the effect of a secreting power in the arteries, upon the internal surface of the periosteum, which produce a portion of a hollow cylinder; this form of bone having been found antecedent to the evolution of any cartilaginous structure; that the ossific matter in the cylindrical bones is deposited primarily in the form of fine thin tubular plates; a mode of deposition of all others the most favourable for their being subsequently remodelled, and for facilitating all the subsequent changes of structure they are destined to undergo;—that in the formation of the cylindrical bones, the ossific

* Medico-Chir. Trans. of London, vol. 6.

surface is arranged into tubular plates of two different sizes, constituting a larger and a smaller series; an arrangement by no means essential to the increase of a bone, because in many of the early stages of ossification, and also where the growth is very slow, the larger series is found to be entirely wanting.

In the flat bones of the skull, the circumstances under which ossification takes place, differ materially from those above described.

In these, the phosphate of lime, in combination with the animal mucilage, is occasionally deposited in small detached unequal masses, without regularity, as if merely laid in the way, preparatory to their subsequent application: these soon become connected with the more central parts of the bone, and are found to decrease in thickness as they increase in breadth, until they are finally consolidated with the original plate of bone.

Is Bone formed within cartilage or between membranes?

This is a point which has been very much disputed, as may be seen by consulting the works of Vesalius, Fallopius, Haller, Albinus, Du Verney, and other authors.

Dr Macdonald's experiments seem to have proved that what has commonly been stated to be cartilage, is either jelly or soft bone.

In the human body, there are examples in which bone is formed on cartilage and also on membranes: in the extremities it is formed on the former, and in the head on the latter.

Bone is frequently formed in cases of disease upon serous membranes, as upon the dura mater and its processes, the peritoneum and pleura. Further, the teeth are formed upon pulps which differ from membrane or cartilage.

Before ossification begins upon cartilage, the cartilage is nearly of the same size as the bone which is about to be formed; and, it may be proper to add, that it is still a question, whether or not the same vessels secrete the bone which have secreted the cartilaginous substance.

Is Bone deposited in a solid or fluid state ?

Solid bone has been supposed by Dr NISBET to exist in the blood : he thought he could perceive bony particles floating in the blood. " What has now been observed concerning the different manners of bony production, and the phenomena which are visible during the progress of ossifications within cartilaginous parts, are fully sufficient to prove all bony particles to be originally contained in the blood, or a fluid secreted from it *."

The above opinion seems to be corroborated by the experiments of Mr BONHOMME, who has stated, that he had found the process of ossification may be accelerated, by mixing a proportion of phosphate of lime with the food of animals; and also, that diseases, originating from a deficiency of earthy matter in the bones, may be cured by similar means. But, notwithstanding the great attention which modern chemists have devoted to the analysis of the blood, they have not discovered in it bony particles.

But the above observations are entirely hypothetical, and throw no light on the subject they profess to explain. Secretion is a much more complex process than the merely straining through vessels certain solids or fluids, which exist in the blood. Bile, urine, semen, mucus, and secreted fluids, are not contained in the blood, nor is the bony matter. Secretion is a very complex process, in proof of which I shall cite an experiment of VAUQUELIN, who confined a hen for a fortnight, carefully examined the food of the animal and the eggs she laid, and found, that in that space of time there was an excess of 500 grains of the carbonate of lime, but that a portion of the silica had disappeared; which is sufficient evidence of secretion of bone being a very different function than is implied by the observations of Dr NISBET or Mr BONHOMME.

It may be observed, upon Mr VAUQUELIN'S experiment, that, as he was not acquainted with the state of the hen when the experiment was begun, it does not determine the exact

* Vid. Human Osteogeny, p. 27.

loss of silica, or the exact quantity of carbonate of lime that was gained.

To me it seems much more probable, that the bony matter which is about to be deposited is held in solution by an acid, probably by the phosphoric acid, which is abstracted from it by the absorbent vessels, or that the bony matter is mixed largely with the lymph. This opinion seems to be confirmed by the appearance of a bone soon after it has been formed, as I have seen in persons who have died while labouring under the disease necrosis. The new formed bone, which supplies the place of the old dead bone, is extremely soft and irregular on its surface; an appearance which the egg also assumes, when within the womb of the hen, or an elephant's tooth, while lodged below the gum.

In consequence of the advancement of the bony process, the bone becomes smooth on its surface, owing to the filling up of the interstices.

Of the Source of Bone.

This subject has been much agitated by physiologists, and has given rise to much contrariety of opinion. According to some authors, the bone is derived from the vessels of the periosteum; and according to others, from the arteries proper to the substance of the bones.

Mr Du Hamel, a strenuous supporter of the first of the above hypotheses, supposed that the layers of the periosteum were gradually converted into bone, in the same manner as timber is formed by the hardening of the white substance between the inner bark and the wood. He endeavoured to give weight to his favourite theory, by feeding animals with madder for a time, and then on ordinary food, by which the bones were rendered alternately white and red.

That the vessels of the periosteum form bone is rendered probable from the effect of external violence, which is in some cases followed by the destruction and exfoliation of the external layers of the bone, and in others, by a new growth of bone, which includes the original bone which has been re-

duced to a gangrenous state, and is cast off; and also, from the phenomena observed during the growth of horns.

My Father entertained a favourable opinion of Du Hamel's theory, and thus expressed himself in his Lectures:

"The periosteum has a greater effect in repairing the loss of bones from accident than Du Hamel himself is aware of. For, from his arguments, and from a number of additional circumstances, it appears, that the supply is very much made by the periosteum, though not entirely so, for the vessels of bones can furnish a matter that is similar to the rest. We find, on breaking the bones of animals, and tracing the fracture, that at first the periosteum around the bone inflames, and swells enormously, beyond what you would imagine, especially if the animal is young. I have seen it one-fourth of an inch in thickness in a pig after a fracture. With time, that is, in the space of a fortnight or three weeks, we find new earthy matter beginning to be deposited.

"Now, some, as Haller, have alleged, that indeed the periosteum swells after a fracture, because it has a certain degree of irritability, but that the swelling subsides again, without producing bone.

"When the callus has been completed, the parts are put together, as nature joins the broken pieces of the branch of a tree.

"The bark, a tough substance, does not readily yield, and on tying up the broken branch of the tree, there is very little growth between the woody parts, and the fracture is healed by a ringlet of wood from the bark.

"Our bones are re-united in the same manner, and the new addition is not confined to the broken place; but if the accident is produced by great violence, there is an addition made to the tables from end to end.

"We might suppose this owing to irritation on the vessels of the bone, but it is owing, in a great measure, to the new addition, and we find cells containing marrow interposed; and when we inject the vessels of the callus, which are numerous and large, we can trace them from the external periosteum.

" I do not affirm that no vessels go in from the ends of the bones; but they are few, compared with those from without.

" Nay, we find vessels running from the callus to the marrow; and though we inflame the marrow, its vessels do not possess the power of generating bone, but rather form a substance like the marrow.

" Next, upon taking out a part of any bone, as of the cranium, we do not find the hole filled up from the sides.

" The sides do swell, from the irritation and inflammation; but there are first a number of vessels shooting from the pericranium, or dura mater, (which is the pericranium within the skull,) and from the extremity of these, a plug is formed like a cork, which plugs up the hole."

My relation Dr MACDONALD, who was a pupil of my Father, and heard him make the above observations, also made a number of very ingenious experiments, which led him to impute the formation of bone to the periosteum.

The distinguished HALLER affirmed, that the periosteum has no share in the formation of bone,—an opinion which was not taken up rashly, but deduced from experiment.

Mr J. HUNTER, in order " to ascertain that the cylindrical bones are not elongated by new matter being interposed in the interstices of the old, made the following experiment: He bored two holes in the tibia of a pig, one near the upper end, and the other near the lower; the space between the holes was exactly two inches; a small leaden shot was inserted into each hole. When the bone had been increased in its length by the growth of the animal, the pig was killed, and the space between the two shot was also exactly two inches *.

" This experiment was repeated several times on different pigs, but the space between the two shot was never increased during the growth of the bone."

There are many instances in which ossification must take place, independently of the periosteum.

The ossification of the extremities of the bones which are in a state of epiphysis, begins in the very centre of the seem-

* Sir EVERARD HOME's Comparative Anatomy, vol. i. p. 65.

ing cartilage; and the same takes place in the knee-pan, and some of the other bones.

The above opinion gains weight, on considering in what manner the medullary canal increases in diameter.

In many instances of preternatural ossification, the periosteum can have no share in that process. I have had occasion to meet with several instances in which a considerable part of the medullary matter of the *brain* has been converted into bone; and with one case, where the greater part of the muscular flesh of the *heart* had undergone a similar change. I have also met with three cases, where a part of the substance of the *placenta* has been reduced to a state of bone.

Upon the whole, to me it seems probable, that the arteries of the periosteum, and also those of the substance of the bone, form bone. The power of the vessels of the periosteum is manifest, and also that of the vessels of the bone, and especially during the growth of bones. In young animals, the medullary canal is very small; an absorption takes place internally, while there is a deposition externally from the vessels of the bone, which bears a certain proportion to the absorption: thus the bones increase in bulk.

Different theories have been published respecting the cause which determines the vessels of the periosteum, or of the bone itself, to begin and carry on the process of ossification.

Some have imputed it to the effect of pressure.

The induration of bones is accelerated by their being exposed, more than any other parts, to the pressure of the great weights they support, to the violent contraction of the muscles fixed to them, and to the force of the parts they contain, which endeavour to make way for their own further growth. By all this pressing force, the solid fibres and vessels of bones are thrust closer; and such particles of the fluids conveyed in these vessels, as are fit to be united to the fibres, are sooner and more firmly incorporated with them, while the remaining fluids are forcibly driven out by the veins, to be mixed with the mass of blood. In consequence of this, the vessels gradually diminish as the bones harden. From which, again, we can understand one reason, why the bones of young animals

sooner reunite after a fracture than those of old, and why cattle that are put too soon to hard labour, are seldom of such large size as others of the same brood, which are longer kept from labour.

But the above theory of my Grandfather, of Baron HALLER, and others, is inadequate to the explanation of the process of ossification, which, in many cases, takes place where pressure cannot exert its influence. Bony matter is secreted from the blood, like the bile or urine, and formed into its proper consistence by the action of the circulating and absorbent vessels, independently of pressure, which cannot therefore be admitted to be the principal cause of ossification. Pressure, after the bones have been formed, may perhaps have some effect in condensing them.

Climate may also accelerate the process of ossification. Whence, in hot countries, the inhabitants sooner arrive at their full stature than in northerly cold regions.

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CHESELDEN's Osteology.
HAVERS's Osteology.
BERTIN's Osteology.
B. S. ALBINUS, Tab. Sceleti Corpor. Human.
De Sceleto Humano.
Annot. Acad. libri octo.
SCARPA, De penit. Ossium structura.
MONRO's Osteology.
Ditto, translated by SUE of Paris.
LOSCHEGE, Progr. de Symmetria corp. humani, imprimis Sceleti,
SOEMMERING's Anatomy, vol. i.

The best figures of the Bones are the wooden figures by CALCARE, in the original edition of VESALIUS and those of ALBINUS.

Authors on National Peculiarities of the Bones.

Herodotus. Vesalius.

Camper on the Natural difference of feature in persons of different countries.

Blumenbach, De generis humani varietate nativa: and his Decades Craniorum diversarum gentium.

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Howship, Med.-Chir. Trans. vol. vi.

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Soemmering's Anatomy, vol. i.; and his Engraving of the Female Skeleton.

CHAP. VI.

OF THE BONES OF THE TRUNK.

THE Skeleton has been usually divided into three great parts, viz. the Bones of the Trunk, Head and Extremities.

There are some authors who begin by describing the bones of the face, then those of the trunk of the body; and, lastly, those of the extremities.

In the following sheets, the Bones of the Trunk are described in the first place, as these form a basis, to which the bones of the head and extremities are fixed, and on which they are moved.

Of the Bones of the Chest.

The trunk of the human body in form, resembles an irregular cone, of which the broadest end is undermost. It is narrow, and open above, to give passage to the windpipe, gullet, large bloodvessels of the superior extremities and thoracic duct, and it gradually becomes broader as it descends, and it is flattened in front.

The form of the thorax corresponds with that of the included bowels; and hence the bad consequences resulting from a deformity of any of its component parts.

The human chest, in shape, differs essentially from that of the inferior animals,—it is broader, comparatively, from side to side,—the breast-bone is broader and shorter; whereas the chest of quadrupeds seems compressed at the sides, by which, the fore-legs are brought nearer to each other; and, therefore, are better calculated to support the weight of the fore part of the trunk of the body.

The chest of animals is also deeper from the breast-bone to the spine: the breast-bone is long and narrow; the ribs, which, in many instances, as in the horse and elephant, are more numerous, and are nearer to the bones of the pelvis, and calculated not merely to contain and defend the heart and lungs, but also to contain and support the bowels of the belly in the horizontal posture of the animal.

The position and movements of the ribs, in respect to the spine, have an evident view to the vital function of breathing.

The spine, the basis of the trunk, extends from the occiput to the end of the rump; and, in many animals, is prolonged so as to form a long tail.

The spine somewhat resembles two pyramids of unequal length, joined by a common basis; and of these, the upper or longer is composed of twenty-four bones, which turn or play upon each other, and hence have been called Vertebræ; but

the lower, or shorter, is composed of bones, which, excepting the undermost, are immoveable. The bones composing the under part of the spine are much larger than those of the upper part, which is peculiar to man, by which he is enabled to maintain his erect position.

Upon looking at the spine, in front or from behind, it seems straight; but when examined in profile, it seems to bear no distant resemblance to the letter S. It projects forwards in the neck, for the better support of the gullet; in the back, it inclines backwards, for the enlargement of the chest; in the loins, it again projects forwards, for the support of the bowels of the belly; and in the upper part of the pelvis, it is reflected backwards for the enlargement of that cavity; and at its lower extremity is turned forwards, for the better support of the intestines; and thus sufficient room is given for the attachment of the requisite number of muscles which support and move the head and trunk of the body. Hence the body is well supported, as the line of gravity which passes through these different curves falls within the space occupied by the feet.

Of the Moveable or True Vertebræ.

The true or moveable vertebræ are twenty-four in number; each has, at its fore part, a thick spongy body, which is in front convex, but concave behind, and plain above and below, and which is perforated by many small holes, through which the bloodvessels enter into the bones, and into which the fibres of the ligaments which connect these bones are inserted. For the sake of additional security, the bodies of the vertebræ, when divided, may be observed to have a sort of case of dense bone, which are joined to these bodies in the form of epiphysis.

Elastic substances of a ligamentous or cartilaginous nature, and consisting of concentric fibres, which are softer towards their centers, are interposed between the several vertebræ. The middle or softer part is the fulcrum or pivot, and is nearly incompressible.

By means of these substances, the body is put as it were upon a series of springs, which tend to lessen or avert the bad effects of violent shocks.

The bodies of the uppermost vertebræ are smaller and more solid; but the inferior are larger and more spongy, and the cartilages between them are thick, and the surrounding ligaments strong, in proportion to the largeness of the vertebræ, and to the quantity of motion they perform; thus the greater weight is supported on the broadest base, whereas there is a greater degree of movement towards the middle of our body.

Processes.—From each side of the body of each vertebræ, a bony bridge is produced backwards, and to a side; from the posterior end of which, a slanting process rises, and another descends. The smooth, and what is generally the flattest side of each of these four processes, which are called the oblique (Articulatorii minimi), is covered with a smooth cartilage; and the two lower ones of each vertebræ are fitted to, and articulated with, the two upper or ascending oblique processes of the vertebræ below, having their articular ligaments fixed into the rough line round their edges.

From between the oblique processes of each side, the vertebræ is stretched out laterally, into a process that is named Transverse.

From the back part of the roots of the two oblique, and of the transverse processes of each side, a broad oblique bony plate is extended backwards; and where these meet, the spinous process of the vertebræ takes it rise, which projects backwards.

The substance of the processes is considerably stronger and firmer, and has a thicker external plate, than the bodies of the vertebræ.

Of the Vertebral Canal.

The vertebræ, when united, form a smooth uninterrupted canal for the spinal chord, which has been called the Spinal or Vertebral Canal. The component pieces of this canal are

bound together in front by a strong ligament, which extends from the second vertebra of the neck to the sacrum, and also by a ligament of a yellowish colour, which lines the posterior and inner surface of the spinal canal: another ligament of a similar description, and which is very elastic, extends between the roots of the spinous processes. The oblique articulating processes being tipped with cartilages, are so connected by their ligaments, as to allow a small degree of motion to all sides. Ligaments also pass in a crucial direction between the vertebræ, the transverse processes are united by ligaments; and hence it is evident, that their centre of motion is altered in different positions of the trunk; for when we bow forwards, the upper moved part bears entirely on the bodies of the vertebræ. If we bend back, the oblique processes support the weight; If we recline to one side, we rest upon the oblique processes of that side, and part of the bodies; and if we stand erect, all the bodies and oblique processes contribute to our support.

On account of the number of the joints of the spine, the spinal marrow, nerves, bloodvessels, &c. are not liable to compression and overstretching by the motion of the trunk of the body, as several vertebræ must be concerned in every motion of the spine; and, therefore, a very small curvature takes place at the conjunction of any two vertebræ. Hence, also, the erect posture is the surest and firmest, because the surface of contact of the fulcra is largest, and the weight is most perpendicular to them. Hence the muscles which move the spine, act with greater force in bringing the trunk to an erect posture, than in drawing it to any other; for, in bending forwards, backwards, or to a side, the muscles subservient to any of these actions are nearer the centre of motion; consequently, the lever with which they act is shorter than when the centre of motion is on the part of the vertebræ, opposite to that where these muscles are inserted, which is the case in raising the trunk. This is extremely necessary, since, in the deflections of the spine from a perpendicular bearing, the weight of the body soon inclines it which way we design; whereas, in raising us erect, this great weight must be more than counteracted.

In calculating the force exerted by the muscles which move the spine, allowance is to be made for the action of the cartilages between the vertebræ, which, in every motion from an erect posture, must be stretched on one side, and compressed on the other, to both which they resist; whereas, in raising the trunk, these cartilages assist by their elasticity.

Owing to the compressibility of the intervertebral cartilages we lose our stature during the day, and regain it during the night, when the weight of the body is taken off the spine.

The different articulations of the vertebræ admit of more extensive motion forwards than backwards, which is of less use, and might have tended to overstretch the bloodvessels, which are contiguous to the bodies of the vertebræ.

Each vertebra at the period of birth consists of a body, a long crooked bone on each side, which forms a small share of the bony bridge, which is completed by the oblique processes, the beginning transverse processes, and the oblique plate, but no spinal processes, so that the teguments are in no danger of being hurt by the sharp end of these while a child is in its bended posture in the womb, nor during labour.

Causes of Deformity of the Spine.

A deformity of the spine may be occasioned by the unequal thickness of the intervertebral substances; thus the spine is thrown off its balance, it inclines to one side, and the intervertebral substances are much compressed on that side, from sustaining the greater share of the weight of the body.

An inequality as to the thickness of the opposite sides of the intervertebral substance, may arise from the bad habit of inclining the body to one side, from palsy, or spasm of the exterior muscles of one side of the trunk of the body.

When there is a curvature, a second turn, but in an opposite direction to the former, must be formed, because the muscles on the convex side of the spine being stretched, contract powerfully, and the patient makes an effort to keep the centre of gravity of the body perpendicular to its base, that the muscles may be relieved from a constant contractile state, which is a source of uneasiness: hence the spine assumes the

form of the letter S. Curvature of the spine also arises from other sources, as from rickets and caries of the bodies of the vertebræ; and when it originates from the latter cause, the spine is generally bent forward at a considerable angle, and sometimes, though more rarely, rickets produce a similar effect.

When the spine is bended, the vertebræ are much thinner on the one side than the other, and sometimes are carious at the place where there is the greatest degree of flexion. I have in my possession a very remarkable specimen of the lateral curvature of the spine, in which all the vertebræ have been united to each other by bony substance, and the ribs, which in this specimen are also much distorted, are fixed to each other by pieces of bone which pass in a transverse direction. The os sacrum in this specimen is also much distorted. The ribs where the spine is deformed must also become distorted, and in different specimens we meet with varieties as to the degree of distortion of the spine and ribs.

The curvature generally extends also to the bones of the pelvis, but there are exceptions to this general rule; for when distortion of the spine does not begin in early life, the pelvis may be well formed, as it is not so liable to be distorted by the weight of the body, as the bones of the spine. A curvature of the spine should not be neglected, especially when it occurs in females, as being often attended by the most serious consequences: thus the lives of many mothers and children may be saved.

The cure consists in counteracting the bending force, by change of posture, or increasing the compression on the convex part of the curvature, and diminishing it on the concave side, by taking off the superincumbent weight by the horizontal posture, and by invigorating the powers of the constitution by tonic remedies. But if the curvature be connected with rickets, other means must be employed: the muriate of lime, when taken for several months, is often of great benefit to such a patient.

I am fully aware that much mischief has been done by machinery, which takes off the weight of the head and upper extremities, and also that much good may be done by calling

into frequent action the muscles of the spine; but when the bones of the spine have become very soft machinery is useful, if constructed by a skilful artist, but if ill made, by removing the weight from the spine, and throwing it upon the bones of the pelvis, by resting upon the spines of the ossa innominata, these are bent forwards, and the ossa ilii and pubis, which form the front of the pelvis, are bent inwards, whereby the capacity of the upper aperture of the pelvis is so much abridged as to be incapable of receiving or of giving passage to the child's head.

In illustration of the mode of treating deformed spine, I have subjoined, from an unpublished manuscript of my Grandfather, his remarks on this head. Speaking of the influence of posture, he observes:

"To illustrate this, I shall relate several cures made by such directions. A boy who had been made weak with a tedious fever, was placed every day for some weeks in an armed chair at the side of the fire, and with his back to the light. His companions were allowed to come in to divert him, and he leant over the arm of the chair farthest from the wall to partake of their plays. His mother shifting him one morning observed his spine very crooked, for which I was consulted. After hearing the history, I ordered the chair to be put at the other side of the fire, as a cure that might be depended on. The mother was affronted at the simplicity of it, which obliged me to order some opodeldoch to rub the back with, but insisted that the chair should be transposed. In two weeks more the spine had got a curvature to the other side, for which I was again consulted, and advised the chair to be put again to its first place, but recommended to the mother to examine the state of the spine every morning, and as soon as she saw it was straight to change the chair every two or three hours from one side of the fire to the other, which was done till the boy was strong enough for rambling about, by which time he was perfectly straight in his back, and has continued so ever since. A girl who had been employed some time in sewing at a tent was observed to have her spine crooked: I was consulted, and advised that she should continue to sew some time longer at

the tent, but to keep the left hand above the stuff she was twilting as she had employed the right one before. She became straight, and then I discharged her sewing more at a tent till at least she was at her full stature and strength. Another girl having got into the habit of putting her right thigh upon her left knee, when she was sitting employed with her needle, and bending her loins and lower part of her thorax towards the right side, while the shoulder, neck, and head, were turned towards the left, became very crooked in her spine. I flattered her to learn to sew with her left hand, and recommended the like posture, but reversed to what she had formerly, that is, to sit with the left thigh upon the right knee, the lower part of her body inclining to the left side, and the upper part to the right side: Whenever she became straight with this, I prevailed on her mother to allow her to sew no more for some years, and then to take care that the child sat straight. She is now a handsome young lady. I could give numerous histories of the like kind, but am afraid to be tedious. In general, let the posture you order a person with a crooked spine to stand, sit, or lie in, be the reverse of the one that contributed to the curvature. Setting one foot forward in standing, sitting on one hip, lying with pillows differently disposed, are great helps; and looking at the effects which they cause when the patient is put into any of these postures, must teach any man of common sense how they ought to be varied in the various cases in which his advice may be asked.

" If the curvature, from the unequal growth of the bones, is considerable, I generally cause the patient to wear stays with plates of steel on the outside of them, which are of such a form, and so fixed, that they may sustain the weight, and so relieve the muscles, and may at the same time counteract the curvature. If the preternatural thickness is in the back part of the vertebra, the body is bended forward with great pain in the back, and the spinal processes hurt the ligaments so much, that they are in danger of ulceration. In such a case, I would cause two thin plates of steel to be fixed to the back part of the stay, with a concave curve in each answering to the part where the curvature is, so that no pressure could be

made by the stays or steel on the spinal processes on any part of the skin that was galled by the prominent bone. Let the lower end of the steel-plates rest on a bolster put on the upper part of the os sacrum, and put a belt round the part of the strap where the steel-plates bear it a little out from the body. A boy who had the two last vertebræ of the back, and the first of the loins, swelled greatly behind, by which he was greatly bended forwards, and could not walk twice through my chamber without great pain and fatigue, had a pair of such stays, made by my direction, applied to him in my house, which was then at the Guard, and walked immediately to Heriot's Bridge in the Grass-market, (near half a mile), without much uneasiness, and became much straighter afterwards by using those stays. Several who were much crooked to aside were cured by a strap with plates of steel at the sides. In all which, instead of putting bolsters in the concave parts, which the common stay-makers always do, with the design of concealing the deformity, I placed the bolster on the convex, where the steel, pressed by the belts, pressed most on the ribs or spine."

The inclination of the Spine forwards often lays the foundation of the most incurable disorders, palsy and œdema of the lower limbs; owing to the degree of pressure upon the spinal cord and vena cava made at the seat of the curvature; and when the ribs also become distorted, asthma, a dropsy of the chest, or phthisis pulmonalis, frequently follow.

Of the True Vertebræ.

The true vertebræ have been divided into three classes, viz. 7 cervical, 12 dorsal, and 5 lumbar, and in some Negroes, 6 lumbar vertebræ have been found. My Father informed me, that he remarked 6 lumbar vertebræ in the skeletons of some giants he had seen at Berlin.

Of the Cervical Vertebræ.

The distinguishing characters of *the seven uppermost or cervical vertebræ*, are; their bodies are smaller and more solid

than any others, and flattened on the fore part, to make way for the *œsophagus*.

They are also flat behind, where small processes rise, to which the internal ligaments are fixed.

The upper surface of the body of each vertebra is made hollow, by a slanting thin process, which is raised on each side; the lower surface is also excavated, the posterior edge is raised a little, and the one before is protruded a considerable way. Thus the cartilages between those bones which are thick, especially at their fore-part, are firmly connected to the bones; hence the vertebræ project forward, as they descend, and have more extensive motion.

The oblique processes are slanting, the upper ones having their smooth and almost flat surfaces facing obliquely backwards and upwards, while the inferior oblique processes have these surfaces facing obliquely forwards and downwards.

Besides the common transverse process rising from between the oblique processes of each side, there is a second that comes out from the sides of the body of each vertebra; and these two processes, after leaving a circular hole for the passage of the vertebral artery and vein, unite, and are considerably hollowed at their upper part, with rising sides, to protect the nerves that pass in the hollow; and at last each side terminates in an obtuse point, into which muscles are inserted.

The spinal processes of these cervical bones stand nearly straight backwards, and are shorter than those of any other vertebræ, and are generally forked or double at their ends, for a more convenient insertion to muscles. But the spinous processes of the cervical vertebræ of quadrupeds are of considerable length, for the origin of the large muscles that support the weight of the head. The extent of motion of this part of the spine is considerable, on account of the thick cartilages between the bodies of these *cervical vertebræ*, the obliquity of their *oblique* processes, and the shortness and horizontal situation of their *spinal* processes. The larger share of the holes for the cervical nerves is formed by the lower of the two vertebræ.

Of the Peculiarities of the Cervical Vertebræ.

First Vertebra or Atlas.

The first, which, from its use of supporting the head, has the name of *Atlas* *, has no body; but, instead of it, there is a bony arch: In the convex fore-part of which, is a small rising, for the insertion of the *musculi longi colli*; and, on each side of this protuberance, a small cavity may be observed, where the *recti interni minores* take their rise.

The upper and lower parts of the arch are rough and unequal, where the ligaments that connect this vertebra to the *os occipitis*, and to the second vertebra, are fixed. The back part of the arch is concave, smooth, and covered with a cartilage, in a recent subject, to receive the tooth-like process of the second vertebra. On each side of the spinal canal, there is a small rough sinuosity, to which the ligaments going to the sides of the tooth-like process of the following vertebra are fixed; and on each side, a small rough protuberance and depression is observable, for the transverse ligament, which secures the tooth-like process in the sinuosity.

Instead of the spinal process, there is a large bony arch, lest the muscles which pass over this vertebra at that place should be hurt in extending the head.

On the back and upper part of this arch there are two depressions for the origin of the *recti postici minores*; and at the lower part are two other sinuosities, into which the ligaments which connect this bone to the following one are fixed.

The superior oblique processes of the atlas are large, oblong, hollow, and more horizontal than in any other vertebra, and are nicely fitted to the *condyloid* processes of the *os occipitis*.

Under the external edge of each of these oblique processes, there is the *fossa*, or deep open channel, in which the vertebral arteries make the circular turn, as they are about to enter the great foramen of the occipital bone, and where the

* Ατλας.

tenth pair of nerves goes out; this fossa is sometimes covered with bone. The inferior oblique processes, extending from within outwards and downwards, are large, concave, and circular. So that this vertebra, contrary to the other six, receives the bones with which it is articulated both above and below.

The transverse processes are not much hollowed or forked, but are longer and larger than those of any other vertebra of the neck, for the origin and insertion of several muscles; of which those that serve to move this vertebra on the second have a considerable lever to act with, because of the distance of their insertion from the *axis* of revolution.

The hole for the spinal marrow is larger in this than in any other vertebra, lest the spinal marrow should be hurt by the motions of this vertebra on the second one; hence this is the broadest vertebra of the neck.

On account of the peculiar conformation of the condyles of the os occipitis, and of the superior articulating processes of the atlas, the head may be readily moved forwards and backwards, but scarcely to either side, or in a circular direction.

Fractures of this vertebra are very rare. Sir A. Cooper has thus described such a case. "He (the patient, a boy), was obliged to walk carefully upright, as persons do when carrying a weight on the head, and when he wished to examine any object beneath him, he supported his chin upon his hands, and gradually lowered his head to enable him to direct his eyes downwards; but if the object was above him, he placed both his hands upon the back of his head, and very gradually raised it, until his eyes caught the point he wished to see. If, in playing with other children, they ran against him, it produced a shock which caused great pain, and he was obliged to support his chin with his hand, and to go immediately to a table, upon which he placed his elbows, and thus supporting his head, he remained a considerable time until the effects of concussion had ceased. He died about 12 months after the accident, and upon inspection of his body, which was conducted by Mr Cline, he found the first vertebra of the neck broken across, so that the dentiform process of the 2d verte-

bra had so far lost its support, that, under different inclinations of the head, it required great care to prevent the spinal marrow from being compressed by it, and as he could not depend upon the actions of the muscles of the neck, he therefore used his hands to support the head during different motions and positions."

In new-born children, the lateral pieces only of this vertebra are ossified; the arch, which it has at its *fore part instead of a body*, being cartilaginous.

Second Vertebra, or Vertebra dentata.

The body of this vertebra is somewhat of a pyramidal figure, being large, and produced downwards, especially at its fore-side, to enter into a hollow of the vertebra below; while the upper part has a square process, with a small point standing out from it, somewhat resembling a tooth, and hence the name *vertebra dentata*. The side of this process on which the hollow of the anterior arch of the first vertebra plays, is convex, smooth, and covered with a cartilage; and it is of the same form behind, for the ligament, which is extended transversely from one rough protuberance of the first vertebra to the other, and is cartilaginous in the middle, to move on it.

A ligament likewise goes out in an oblique transverse direction, from each side of the *processus dentatus*, to be fixed at its other end to the first vertebra, and to the occipital bone; and another ligament rises up from near the point of the process to near the os occipitis.

The superior oblique processes of this *vertebra dentata* are large, circular, very nearly in an horizontal position, and slightly convex, to be adapted to the inferior oblique processes of the first vertebra.

The inferior oblique processes of this vertebra dentata, are similar to those of all the cervical vertebræ.

The transverse processes of the vertebra dentata are short, very little hollowed at their upper part, and not forked at their ends; and the canals through which the cervical arteries pass, are reflected outwards about the middle of each process; so that the course of these vessels may be directed towards the

transverse processes of the first vertebra. Thus, there is no risk of the blood being interrupted in its course.

The spinal process of this vertebra is thick, strong, and short, to give sufficient space for the origin of the *musculi recti majores*, and *obliqui inferiores*, and to prevent these and other muscles being bruised, whilst the head is pulled backwards.

This second vertebra consists, at the birth, of four bony pieces: Besides the three pieces, common to all the vertebræ, the tooth-like process of this bone is ossified in its middle, and is joined as an appendix to the body of the bone. Lest this appendix be bended or displaced, nurses ought to keep the heads of new-born children from falling too far backwards, by *stay-bands*, till the muscles shall have attained strength sufficient to prevent that dangerous motion.

In consequence of violence, the transverse ligament which retains the dentiform process in its place, has sometimes been torn, in consequence of which, it immediately falls backwards, and, by its pressure on the spinal cord, proves fatal.

The head is moved forwards and backwards on the first vertebra, while the atlas performs the *circumgyratio* upon the second vertebra; the inferior oblique processes of the atlas turning on the superior oblique processes of the second, and its anterior arch revolving on the tooth-like process, by which the perpendicular ligament that is sent from the point of the tooth-like process to the occipital bone is twisted, while the lateral ligaments that fix the *processus dentatus* to the sides of the first vertebra, and to the *os occipitis*, are very differently affected; for the one upon the side towards which the face is turned by the *circumgyratio*, is much shortened and lax, while the opposite one is stretched and made tense. The lateral ligaments prevent the head from turning any farther round on this axis, and are the proper *moderators* of the *circumgyratio* of the head. As these ligaments are weaker or stronger, longer or shorter, and more or less capable of being stretched in different individuals, the head may be revolved to a greater or less extent.

The first vertebra also may be moved a little to either

side; but is prevented from moving backwards and forwards, by its anterior arch, and by the cross ligament, which are both closely applied to the tooth-like process. Motion forwards here would have been dangerous, for thus the beginning of the spinal marrow must have been brought into contact with the point of the tooth-like process.

By the rotatory motion of the head, objects are readily and quickly presented to the organs of senses.

The *lateral* or *moderator* ligaments confine so much the motion of the first vertebra upon the second, that, though this joint may serve us on several occasions, yet we are often obliged to turn our faces farther round, than could be done by this joint alone, without the greatest danger of twisting the spinal marrow too much, and also of luxating the oblique process; therefore, on turning the head in a greater degree, all the vertebræ of the neck and loins also are rotated.

The seventh * vertebra of the neck resembles in form those of the back, having the upper and lower surfaces of its body less hollow than the others: The oblique processes are more perpendicular; neither spinal nor transverse processes are forked.

The transverse process of the sixth and seventh cervical vertebra, are more frequently divided by a small cross bridge, that intervenes between the cervical vein and artery, than in any of the other vertebræ.

Dorsal Vertebræ.

The distinguishing characters of *the twelve dorsal* vertebræ, are, their being of a middle size between the cervical and lumbar vertebræ, prominent in front, flattened on their sides, for their articulation with the ribs, and being horizontal as to their upper and under surfaces.

The cartilages interposed between the bodies of these vertebræ are thinner than in any other of the *true vertebræ;* and contribute to the concavity of the spine in the thorax, by being thinnest at their fore part.

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* Atlas quibusdam, maxima, magna vertebra, prominens.

The *oblique* processes are placed almost perpendicular ; the upper ones slanting but a little forwards, and the lower ones slanting as much backwards.

Between the oblique processes of opposite sides, several sharp processes stand out from the upper and lower parts of the plates which join to form the spinal process; into these sharp processes, strong ligaments, which connect the vertebræ, are fixed.

The *transverse* processes of the *dorsal vertebræ* are long, thicker at their ends than in the middle, and turned obliquely backwards; which may be owing to the pressure of the ribs, the tubercles of which are inserted into a depression near the end of these processes.

The spinal processes are long, small pointed, and sloping downwards and backwards; from their upper and back part, a ridge rises, which is received by a small channel in the fore part of the spinal process immediately above, which is here connected to it by a ligament.

The spinal canal is circular, and smaller than in any of the other vertebræ, and a larger share of the holes in the bony ridges, for the transmission of the nerves, is formed in the vertebra above, than in the one below.

The connection of the *dorsal vertebræ* to the ribs, the thinness of their cartilages, the erect situation of the oblique processes, the length, sloping, and connection of the spinal processes, contribute to limit the motion of those vertebræ, which might have interrupted the actions of the heart and lungs. In consequence of the little motion allowed here, the *intervertebral* cartilages sooner shrivel; and, therefore, as people advance in life, they become round-shouldered.

The bodies of the four uppermost *dorsal vertebræ* are the largest, and the other three below gradually become smaller, to allow the trachea and large vessels to divide at smaller angles.

The two uppermost vertebræ of the back, instead of being very prominent forwards, are flattened by the action of the *musculi longi colli* and *recti majores.*

The proportional size of the two little depressions in the

body of each vertebra for receiving the heads of the ribs, seems to vary in the following manner: The depression on the upper edge of each vertebra decreases as far down as the fourth, and after that increases.

The transverse processes are longer in each lower vertebra to the seventh or eighth, with their smooth surfaces, for the tubercles of the ribs, facing gradually more downwards; but afterwards as they descend they become shorter, and the smooth surfaces are directed more upwards.

The spinous processes of the vertebræ of the back become gradually longer and more slanting from the first as far down as the eighth or ninth vertebra; from which they manifestly turn shorter and more erect.

The first vertebra, besides an oblong hollow in its lower edge, that assists in forming the cavity wherein the second rib is received, has the whole cavity for the head of the first rib formed in it.

The second has the name of *axillary*, without any thing particular in its structure.

The eleventh * often has the whole cavity for the eleventh rib in its body, and wants the smooth surface on each transverse process.

The twelfth † always receives the whole head of the last rib, and has no smooth surface on its transverse processes, which are very short.

The smooth surfaces of its inferior oblique processes, face outwards. In short, the upper vertebræ of the back resemble those on the neck; and the lower ones those of the loins.

Lumbar Vertebræ.

The lumbar are the lowest of the five *true vertebræ*, which may be distinguished from the others.

1. Their bodies, though of a circular form at their fore part, are somewhat oblong from one side to the other. The *epiphyses* on their edges are larger, and therefore the upper

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* Ἀρρεπὴς, in neutram partem inclinans.

† Διασωστηρ, præcingens.

and lower surfaces of their bodies are more concave than in the vertebræ of the back.

2. The greater thickness of the intervertebral cartilages in front render the spine convex towards the abdomen.

3. The oblique processes are strong and deep; those in opposite sides being placed almost in parallel planes; the superior, which are concave, facing inwards, and the convex inferior ones facing outwards; and therefore each of these vertebræ receives the one above it, and is received by the one below.

4. Their transverse processes are small, long, and almost erect, for allowing large motion to each bone, and sufficient insertion to muscles, and for supporting and defending the internal parts.

5. A small protuberance may be observed at the roots of the superior oblique and transverse processes, for the insertion of the exterior muscles of the trunk of the body.

6. The spinal processes are strong, straight, and horizontal, with broad flat sides, and a narrow edge above and below; this last being depressed on each side by muscles; and, at the root of these edges, there are rough surfaces for fixing the ligaments.

7. The canal for the spinal cord is rather larger than in the vertebræ of the back.

8. The holes for the passage of the nerves are more equally formed out of both the contiguous vertebræ than in the other classes; the upper one furnishes, however, the larger share of each hole.

The thick cartilages between these *lumbar vertebræ*, their deep oblique processes, and their erect spinal processes, are calculated to admit of extensive motion; though it is not so great as what is performed in the neck; as appears from comparing the arches which the head describes when moving on the neck, or the loins only.

The oblique processes of the lower lumbar vertebræ are at a greater distance from each other, and facing more backwards and forwards.

The transverse and spinal processes of the third and fourth

vertebræ of the loins are the longest and thickest; but these processes are less prominent in the first and last lumbar vertebræ, lest the ribs or ossa innominata and muscles covering these, had been injured during the movements of the spine.

The epiphyses which encircle the edges of the bodies of the two inferior vertebræ are deeper than in the other vertebræ; hence their greater hollowness in the middle.

The body of the fifth lumbar vertebra is rather thinner than that of the fourth. The spinal processes of the fifth are smaller, and the oblique processes face more backwards and forwards than in the other lumbar vertebræ.

From what has been stated as to the intimate conjunction of these lumbar vertebræ, it is evident they cannot be disjoined excepting in consequence of great violence, and excepting the processes be at the same time broken.

This opinion which I have always stated, has been confirmed by the observations of that very experienced surgeon Sir A. Cooper, who has observed: "I have never witnessed a separation of one vertebra from another, through the intervertebral substance, without fracture of the articular processes, or, if those processes remain unbroken, without fracture through the bodies of the vertebræ *."

In the unedited manuscript of my grandfather, he has stated: "I have seen the thickness of one side of one or more vertebræ mistaken for a luxation, and it seems long to have been so mistaken, otherwise such violent methods would not have been proposed for the reduction as you may see in Scultetus. The symptoms of the two diseases are so far the same, that in both there is a preternatural curvature of the spine, with an appearance of thickness on one side of the vertebra, that they can both give very violent pain to the patient, that they can both produce a palsy in all the parts below where the tumor is, with involuntary excretion of fæces and urine; but then there is no manner of difficulty in distinguishing the one from the other. When there is a luxation, the curvature is made at once by some violence or quick twist of the

* Vide Treatise on Dislocations and Fractures, p. 539.

spine, when it was bended; the pain is immediately very violent, and the paralytic symptoms come on in a short time after the luxation: whereas, in the curvature from the unequal growth of the vertebræ, the curvature encreases very slowly; till the curvature is great, the pain is not violent, and the palsy don't appear till the swelling has become large. I have seen three people who have had palsies from the gradual swelling of the vertebræ, but I never saw one luxation of them, though I allow it is not an impossible case. Probably several histories of luxation are recorded, which, on a strict examination, might have been found to be a preternatural growth of one side of a bone."

Of Imperfection as to the Formation of the Spine.

Before concluding respecting the vertebræ, it may be proper to add, that the spinal processes of the cervical, dorsal or lumbar vertebræ, are occasionally awanting at birth, and most frequently those of the latter; and in a very few instances those of the os sacrum. According to HOCHSTETTER, some of the transverse and oblique processes of the vertebræ are also deficient in a few cases; and according to MARET *, the whole spinal canal has been open.

In these circumstances, the membranous sheath of the spinal canal is protruded through the aperture in the bones, forming a sac which is filled by a yellowish fluid; but sometimes it is reddish, from a slight admixture of blood.

The tumour is soft, elastic, of a rounded or oval form, and generally about the size of a billiard ball, and has commonly a broad basis.

The tumour gradually becomes larger; and at length becomes peculiarly prominent at a certain part, which inflames and ulcerates, and gives way; upon which its contents are discharged, and the child dies.

When the tumour takes place in the loins, some of the nerves which form the cauda equina are distributed over the inner surface of the sac.

* Vide Mem. de Dijon, vol. 2.

The spinal cord has been said to be softer at the seat of the protrusion than is natural; but I have not always observed this to take place.

This imperfection is sometimes complicated with Hydrocephalus internus; so that when the head is laid lower than the rest of the body, the tumour in the back loses of its bulk, and the symptoms of oppressed brain come on, which are speedily removed on elevating the head. This disorder is generally of short duration, proving fatal in a few weeks, when the tumour bursts. There are, however, a few exceptions to this general observation. I possess a specimen in which the tumour burst repeatedly, and the patient lingered under the disease for upwards of a year: my father had a patient with the complicated form of the disease, who lived for five years; and there are a few instances on record, where the disorder has been of longer duration.

There is another kind of malconformation of the vertebræ, which, as far as I know, has not been described by any author. I have seen four instances of it. In this malconformation, the spinous and inferior articulating processes of the last lumbar vertebra, which form the posterior part of the bony ring, are connected to the rest of the vertebræ only by the medium of strong ligamentous substance.

In the skeleton of an Australasian, less than one-half of the bony ring is detached from the body of the bone, and also rather less than one-half of the spinous process of the last lumbar vertebra: in the skeleton of a Negro, the transverse process of the last lumbar vertebra of the left side, which is much enlarged, is connected by intervertebral substance to the uppermost piece of the os sacrum, and the outer surface of the process enters for the space of an inch and a half into the formation of the sacro-iliac symphysis on the left side: in a third specimen, the whole of the bony ring, consisting of the inferior articulating and spinous processes, is detached from the body of the bone: and in a fourth specimen, there was precisely the same malconformation of the last vertebra as in the Negro.

CHAP. VII.

OF THE IMMOVEABLE PORTION OF THE VERTEBRAL COLUMN.

THE lowest portion of the spine, or its inferior pyramid, does not contribute to the motion of the trunk of the body, nor do its component bones (the ossa coccygis excepted), move upon each other; hence these have been called *false vertebræ.*

These immoveable vertebræ constitute the back part of the pelvis or basin.

Of the Pelvis.

The bones of the lower part of the trunk of the body form the pelvis, which varies in its size, proportions and symmetry, in men of the same age, nation and sex, and still more so in the different inferior animals.

The pelvis should be regarded, 1*st*, as a firm basis, on which the bones of the trunk are moved, and also those of the inferior extremities; and, for this purpose, it is the firmest part of the skeleton, for its component bones are firmly fixed to each other by the form of their articulating surfaces, by numerous muscles, tendons, and by ligaments; and the form and size of the component bones give place to the muscles requisite for these several actions.

2*d*, As a cavity for the lodgement and defence of the organs of urine and generation; for a part of the intestines and the bloodvessels, nerves and absorbent vessels, and the glands proper to these; and for the muscles which assist in discharging the contents of the included bowels.

3*d*, As having, by the magnitude and arrangement of its several parts, a reference to the erect posture, for which pur-

pose it is more expanded in man behind, and also laterally, than in the inferior animals; for, in the latter, the distance between the opposite sides of the pelvis is so trifling, that they cannot, without a great effort, maintain an erect position even for a short time, for the ossa innominata are small, and the os sacrum and ossa coccygis are in the same line as the vertebral column; and therefore ill calculated for supporting the bowels of the pelvis, when they are pressed downwards by the powerful action of the diaphragm and abdominal muscles.

The prominent and thick tuberosities of the ossa ischia form a basis on which we rest in sitting, and as these bones are parallel to each other, and to the line of gravity of the body, the body is equipoised when we sit erect; whereas, if the os sacrum and ossa coccygis had formed a part of the same straight line as the spine, they must have projected beyond the other bones, and have prevented us from sitting; and, it may be added, that the peculiar direction of these bones, renders the inferior animals retro-mingent and retro-copulent.

The greater breadth of the bones of the pelvis gives sufficient room for the large and powerful extensor muscles, which keep the body erect; hence the much greater bulk of the human hips.

The pelvis is composed of three large flat shaped bones, the os sacrum and ossa innominata, which are intimately conjoined by very peculiarly constructed joints, by strong and numerous ligaments, and by muscles.

The ossa coccygis are fixed to the lower and smaller extremity of the os sacrum, and are appendages to that bone: they are so situated, as to give a certain degree of support to the intestinum rectum, and, when drawn backwards, the lower aperture of the pelvis is thereby increased.

The mechanical disposition of the component bones of the pelvis is admirably constructed for supporting the superincumbent weight.

The os sacrum, which is somewhat triangular in shape, having the longest side of the triangle uppermost, is firmly

wedged in between the ossa innominata; and, when depressed by the weight of the body, forces together the ossa innominata at the symphysis pubis, and renders the bond of union between them still more intimate.

A certain proportion of ligament enters into the construction of the pelvis; thus sufficient space is given for the origin and insertion of the requisite number of muscles; the weight is not increased, and the bad effects of shocks which the body otherwise must have sustained whilst violently agitated, as in dancing, leaping, running, or descending from a height, are averted.

The pelvis has been divided into three parts, the brim or introitus, the cavity, and the inferior aperture or exitus.

The true, or lower, pelvis has been said to be composed of a cavity, and of an upper and under aperture.

The line extending backwards from the ossa pubis to the ossa ilia, is the line which marks the upper aperture of the true pelvis, which looks upwards and forwards in the erect position, but the inferior aperture, which is much contracted by muscles, and by ligaments extended between the os sacrum, ossa coccygis, and ossa ischia, looks downwards and backwards.

Of the Axis of the Pelvis.

The axis of the pelvis varies much in the different attitudes of the body, and even in the same attitude at different periods of life.

In the erect position, the line of the axis of the upper aperture of the pelvis, extending between the navel and the extremity of the ossa coccygis, forms a considerable angle with the line of gravity of the body; and hence the bowels of the pelvis are well supported: owing, also, to the oblique position of the pelvis in the erect posture, and from the peculiar position of the thigh bones in respect to it, the line of support corresponds with that of the lower extremities.

The axis of the inferior aperture, is nearly in a line with that of the vagina, and forms a considerable angle with that

of the upper aperture: labour, therefore, is more difficult in the human race than in inferior animals.

The pelvis varies much as to its size, and the proportions of its different parts in different women, in the inhabitants of different nations, and also at different periods of life.

In the standard pelvis, a line drawn from the sacrum to the pubis, measures rather more than 4 inches, from one os ilium to the other 5 inches and $\frac{1}{4}$; and in the lower part, or inferior aperture of the pelvis, these proportions are reversed; for a line from the symphysis pubis, to the os coccygis, allowing an inch for the retraction of that bone, is equal to 5 inches. The standard pelvis is about $3\frac{1}{2}$ inches from the brim to the tuberosity of the os ischium, 6 inches behind, and the depth of the symphysis pubis is about $1\frac{1}{2}$ inch.

In order to throw light on the measurements of the female and male pelvis, I selected several pelves of both sexes, which I considered to be very well formed, and also several that are very much deformed; and I have subjoined a tabular view of the measurements, taken in different directions, by my excellent assistant Mr Mackenzie. All the measurements were taken from inside to inside *.

In the subjoined Table, I have given the measurements only of the pelvis of one Negress, as the other I possess, which was also sent to me by Professor Horner of Philadelphia, corresponds, in all respects, with it.

It may be proper also to state, that the pelvis of a Negro, which the same gentleman sent to me, is rather less than that in the Table.

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* In my Outlines of Anatomy, I published many valuable observations on the pelves of women of different nations, by that justly celebrated anatomist Dr P. Camper, which are illustrated by a diagram drawn by himself, to which I refer the reader.

Mr Mackenzie, from his zeal to communicate information, measured, after the types of this sheet were set up, five female pelves, in the possession of a friend, which he found to measure somewhat less than those of the subjoined Table.

Dr Hull's tablns as to the distorted pelvis merit the particular attention of the reader.

TABLE I.—*Measurements of well formed Pelves.*

Number.	Sex,	Antero-Posterior Diameter, from top of Os Sacrum to the Symphysis Pubis.	Oblique Diameter, or from Sacro-Iliac Symphysis of one side, to the middle of the Acetabulum of the opposite side.	From side to side, or Lateral Diameter.	Depth from top to bottom of Os Sacrum in a straight line.	Transverse Diamet. of Outlet, or from opposite Tuberosities of Ossa Ischia.	Distance from extremity of the Sacrum to the Symphysis Pubis.	Distance from Sacro Iliac Symphysis to the Symphysis Pubis.	Distance from upper part of 4th bone of Sacrum to under part of Symphysis Pubis.	Height of Skeleton.
										ft. in.
1	Female,	4½	5	5⅛	4⅜	5⅛	5	4⅞	5⅝	
2	Female,	4⅛	5	5⅜	4	5⅛	5	5	5⅜	
3	Female,	4⅝	5⅜	5⅛	4	4⅜	4⅝	4⅝	5⅜	
4	Female,	4½	5⅛	5⅜	4⅜	4⅜	5⅜	4⅝	5⅜	
5	Female,	4½	5	5⅛	4⅜	5⅜	5⅛	4⅝	5⅝	5 2
6	Negress,	4⅛	4½	4⅝	3⅝	3½	4⅝	4⅛	5⅛	5 4
7	Male,	4½	4⅛	4¼	4⅜	3⅝	4⅝	4⅛	3⅝	4 6¼
8	Negro,	3⅝	4⅜	4⅛	3⅝	3	4	4	4⅜	5 6
9	Male,	4¼	4⅝	5	4½	3⅝	5⅜	4⅜	4⅜	5 6
10	Male,	4	5⅛	5½		4⅛		4⅞	5⅛	6 0
11	Male Austral-asian,	4⅜	4⅜	4⅜	3⅞	3⅛	3⅞	4⅜	4⅝	5 6½

TABLE II.—*Measurements of Deformed Female Pelves*

12	Female,	1½	Right 4 Left 4⅓	5	4⅛	4⅜	3⅜	3⅝	Left 3½ Right 3
13	Female,	3	Right 3½ Left 3	4	3	2	2½		
14	Female,	2⅛	4½	5¼	3½	4⅛	3½	3¾	4¼
15	Female,	3½	5⅛	5¼	4½	4⅝	4¼	4¼	4⅜

From the table it follows,

1*st*, That in a well formed pelvis, the antero-posterior diameter is somtimes equal to four and a half inches; but that in the Negress, it is considerably less; and, in the female deformed pelvis, it is sometimes equal only to one and a half inch: That in the male, it is not proportioned to the stature of the body, for in the skeleton which measured six feet, it was less than in the other two male skeletons of inferior stature.

2*d*, That, in a well formed female, the conjugate diameter of the pelvis generally equals five inches, and sometimes exceeds it a little; but in the Negress it is less, and is also still less in three of the deformed pelves. The mollities ossium, therefore, does not tend to diminish this diameter of the pelvis so much as the antero-posterior diameter.

The oblique diameter of the male pelvis did not (excepting in No. 10.), equal that of the female pelvis.

3*d*, That the lateral diameter of the pelvis in the skeleton is greater than the oblique; but in the recent body, it must be less, this aperture being diminished by the psoæ and iliaci interni muscles; and it merits notice, that the mollities ossium does not materially lessen the lateral diameter of the upper aperture of the pelvis.

This diameter is not so great even in a tall man, as in a female who is shorter by several inches.

4*th*, That the depth of the os sacrum, from top to bottom, was less in the Negress than in the European, and still more so in one of the deformed pelves I measured; and in the other deformed pelves, it was reduced even in a greater degree.

In the Negro, also, the depth of the os sacrum was inferior to that of the sacrum of the male European.

5*th*, That the transverse diameter of the outlet varied considerably, even in the well-formed pelvis of the European female, in some specimens exceeding 5 inches; but in others exceeding by a little 4 inches only: that in the Negress, it was nearly an inch less than in the European, and in one of the deformed pelves it equalled only 2 inches.

In the Negro and male European, there was but little dif-

ference as to this diameter of the pelvis, but it was rather less in the male Australasian than in the male European.

6th, That the distance between the extremity of the os sacrum and the symphysis pubis was less in the Negress than in the female European, and rather less in the Negro than in the male European. In three of the deformed pelves, the distance equalled little more than 3 inches.

7th, That the distance between the sacro-iliac symphysis, and symphysis pubis, was also less in the Negress, and in the male from Australasia, than in the European female; and still less in one of the deformed pelves.

8th, That the distance between the fourth piece of the os sacrum and under part of the symphysis pubis, was much less in the Negress compared with the other diameters of the pelvis, than in the European female, and that this diameter in the deformed pelvis was also less than in the well formed pelvis.

In short, the pelvis of the Negress is smaller in all its diameters than that of the female European; and the same holds true in respect to the Negro, when compared with that of the male European.

The preceding table also indicates the distinctive characters of the male and female pelvis.

The female pelvis is evidently larger in all its dimensions, except the height, than that of the male; hence women take more room in sitting.

The ossa ilia spread out wider, and thus the enlarged womb is better supported. The brim or upper aperture of the female pelvis is somewhat of an oval shape, corresponding in form to the head of the child; that of the male more nearly approaches to a circle.

On directing the attention to the several parts of the female pelvis, each is found to be proportionally larger, so that the greater circumference of the female pelvis does not depend upon the greater expansion of any one particular part. The incurvation of the os sacrum and ossa coccygis, which is peculiar to the human race, is greater in the female, as also the breadth of the bones; and the bond of union between the several component pieces of the os coccygis is more loose,

which renders these bones more moveable; and hence they may be pushed backwards about $\frac{3}{4}$ths of an inch during labour, which considerably enlarges the under aperture of the pelvis, and facilitates delivery.

The size of the notch in the ilium is larger in the female: the effect of this is, that, by encreasing the arch, the ossa ischia are at a greater distance from the os sacrum, and from each other; from this circumstance, therefore, the breadth of the pelvis is greatly encreased.

The greater size of the foramina thyroidea has not been sufficiently attended to: thus the conjoined os ischium and pubis form a larger circle.

The upper aperture is also considerably larger in the female than in the male pelvis, the os sacrum is broader; and the distance between that bone and the symphysis pubis is greater; and in the recent body, there is a remarkable difference in the thickness of the one or the two cartilages between the ossa pubis, which are not so deep as in the male *.

Lastly, The ossa pubis in the male, form, by their junction, an acute angle; but, in the female, the angle is wider considerably. In short, the cavity of the pelvis, or true pelvis, is larger in the female, and bears a greater proportion to the upper part of the pelvis. It is broader in all its dimensions; hence the tuberosities of the ossa ischii, the acetabula, and spinous processes of the ossa ilii, are farther distant from each other; and of course the thigh-bones of the female are placed more obliquely.

Of the Distortion of the Female Pelvis.

The preceding tables give a comparative view of the different diameters of the well formed and distorted pelvis.

The above measurements of the four distorted pelves of the female, indicate only some of the deviations from the natural form. As it was almost impossible to give accurate measurements of all the different diameters of the distorted pelves, I have added a few remarks on the distorted pelves in the mu-

* Vide Tenon, Mem. de l'Institut des Sciences, tom. vi. p. 172.

seum bequeathed to the University by my Father, and of those belonging to my colleague Dr HAMILTON, who informed me, that seven of those in his museum belonged to women on whom the Cæsarean operation had been performed.

All the deformed pelves were unusually light and soft, with the exception of one; and the most deformed were the most remarkably so, which is sufficient evidence, that the component bones of the pelvis cannot, like those of the spine, take on an unnatural form, unless when diseased. The distortion is sometimes limited to the upper or under apertures, but generally it is common to both.

The rickety pelvis yields under the weight of the body, by which the lumbar vertebræ and the upper part of the os sacrum are bent forwards, or to a side; after which, the iliac portions of the ossa innominata are bent inwards: those parts of the pelvis opposed to the heads of the thigh bones are pressed upwards and inwards. Hence the symphysis pubis projects beyond the general sweep of the upper aperture to the distance of an inch and a half, or two inches: in the specimen most remarkable for deformity, the acetabula of the opposite sides had been pressed into immediate contact.

The upper aperture of the pelvis had, in the greater number of specimens, somewhat resembled an egg-plumb, laid transversely, and compressed in the middle of one side; but in the more distorted specimens, the fore and back parts of the upper aperture, to which the pressure is more directly applied, were distant from each other only two inches, or one inch and a half, owing to the projection of the last lumbar vertebra and upper part of the os sacrum, but the distance between the opposite ossa ilia was not much diminished. The depth of the pelvis was also diminished; for the sacrum had yielded under the weight of the body, and to such an extent, that the upper and under surfaces of it were not distant from each other above two or three inches.

The lower end of the deformed sacrum, together with the ossa coccygis, project inwards upon the lower aperture of the pelvis, and diminish the distance between the fourth piece of the os sacrum and symphysis pubis. Owing, also, to the pressure

of the body, the tuberosities of the ossa ischia, of opposite sides, approach each other.

In short, the soft pelvis placed between two forces, compressing it in opposite directions, receives and retains the impression of these.

The rami, forming the angle of the pubis, in two of the specimens, were in form like the letter S, and in one of the specimens they were in contact near an inch and a half under the symphysis pubis, and then retreated from each other, forming a portion of a circle, the concavities of which looked towards each other; and about half an inch above the tuberosities of the ossa ischia, they came almost into immediate contact with each other.

But, in another specimen, in which all the bones of the body were very much distorted, the tuberosities of the ossa ischia were more distant from each other than in a well-formed pelvis.

Lastly, From the os sacrum being quite straight, the cavity of the pelvis is reduced below the natural standard, though the brim and outlet are sufficiently large.

" We shall next consider in what way the pelvis may be made wider for the passage of the child."

" Mr Sigault has, in 1768, suggested an operation for this purpose, in which the symphysis of the ossa pubis is divided, with a thin scalpel; after which, using the thigh-bones, bended to a right angle with the trunk of the body, as levers, the ossa innominata are pushed asunder, and the ligaments joining them to the os sacrum stretched, as is said; but, in reality, not only the cartilages which glue them to the sacrum, but the capsular ligaments, must be, in some degree, lacerated."

" By this operation, the ossa pubis might be separated from each other one inch or more; and of course the tubera of the ossa ischia will be separated from each other about one-half of that space, and the sides of the transverse diameter of the pelvis nearly half an inch also. As the ossa innominata are moved as it were upon hinges, placed at the back part of their articulation with the sacrum, whilst they are pushed asunder, they will be advanced forwards, because the lines

drawn from the articulations of the ossa innominata with the sacrum to the symphysis pubis, are now raised from oblique to more perpendicular situations."

It may also be observed, that the convex back part of the os occipitis of the child may pass down in the opening between the ossa pubis; and, as the head of a child at birth can be altered in its shape, that a still greater portion of the head may pass down in that opening, than if the head had been quite rigid.

This operation will therefore be of use where a small addition to the distance between the ossa pubis and sacrum will be sufficient for the delivery of the child.

It will be of still greater use, if the obstruction to delivery be owing to the smallness of the space between the ossa ischia, at the lower part of the pelvis, as the distance between these and also between the opposite sides of the pelvis at the extremities of the transverse diameter of its upper part, may be increased to one-half of the distance between the divided ossa pubis. But if the bones are so distorted as to straiten the passage much (which ought to be examined), this operation will be of little or no use; and, by it, the life of the mother will be endangered, without saving that of the child.

The effects of this operation have been exaggerated, from its having been done where the pelvis was little, or not at all contracted. Thus in one of the first cases, operated by Le Roy, in 1777, and which has been generally quoted, as giving great encouragement to the performance of this operation, the woman had formerly been delivered of a full grown living child, from which I think we may conclude, either that the operation had been unnecessarily performed, or that a very small addition to the width of the pelvis was sufficient. From the nature of the operation, and from the accounts we can collect of its success, the danger following it must be greatly less than that of the Cæsarean operation; but, as yet, the cases are not so numerous as to enable us to determine the degree of danger with much accuracy *."

* The above observations on Sigault's operation, are taken from my Father's Lectures.

Of distortion of the Male Pelvis.

The observations which have hitherto been made apply to the distortion of the female pelvis.

The male pelvis is also liable to distortion, and as that distortion may render the lateral operation of lithotomy very difficult or impossible, it is of moment to draw the attention of the reader to it, and the more especially, as it has been very generally overlooked, and that even by authors who have directed their attention in a more especial manner to the pelvis.

An unnatural conformation of the rami which form the angle at the symphysis pubis of the male pelvis is, as far as my observation goes, by no means unfrequent. This malconformation of the bones is combined with a corresponding deviation as to the origin of the crura penis, the one of which takes its origin more than half an inch higher than the other on the opposite side.

In some instances the rami of the pubis approach each other so closely, that there is not sufficient space between the tuberosities of the ossa ischii for performing the lateral operation of lithotomy, but more frequently one of these retreats, so that one of the rami of the pubis resembles that of the male; and the other, that of the female.

This deviation from the natural form may often escape observation, as I have seen it, when all the other bones of the body have been perfectly well formed, and in very robust men. I lately got two specimens, in one of which, that portion of the pelvis, between the symphysis pubis and tuberosity of the right os ischium, is nearly parallel to the urethra; but the similar portion of the left side, is nearly as oblique as that of a well-formed female pelvis; and the reverse holds true as to the other specimen.

When the bones of the male pelvis acquire, in consequence of rickets, an unnatural softness, they sometimes become much distorted, in consequence of the weight of the upper part of the trunk and extremities. There is a remarkable specimen of this in the skeleton of a boy of four or five years old, in the Museum, whose spine, pelvis, ribs, and bones of the extre-

mities, are deformed to as great a degree as any of the female pelves.

OF THE PARTICULAR BONES OF THE PELVIS.

Of the Os Sacrum.

The transverse processes on each side of this bone are united into one large mass, which is thick, and divided into two irregular cavities, by a long perpendicular ridge. The foremost of the two cavities has commonly *a thin cartilaginous skin* covering it in the recent subject, and is adapted to the unequal protuberance of the os ilium, and a strong ligament connects the circumference of these surfaces of the two bones. The cavity behind is divided by a transverse ridge into two, where strong ligaments that go from this bone to the os ilium, with a cellular substance, containing mucus, are lodged.

The transverse processes of the two last bones of the os sacrum are much smaller than those of the former. At their back part near the edge, a knob and oblong flat surface give rise to two strong ligaments which are extended to the os ischium; and are therefore called *sacrosciatic.*

The spinal processes of the three uppermost bones of the os sacrum are short, sharp, and almost erect, but the two lower are open behind; and sometimes a little knob is to be seen on the fourth, though generally it is bifurcated, without the two legs meeting into a spine; in which condition also the first is often to be seen; and sometimes a fossa, instead of a canal, is left *. These spinous processes give rise to the latissimus and longissimus dorsi, sacro-lumbalis, and glutæus maximus, muscles.

Canal.—The *canal* between the bodies and processes of this bone, for the cauda equina, is triangular; and becomes smaller as it descends, as the cauda also does. Below the third bone, this passage is no more a complete bony canal, but is open behind; and is there defended only by a strong liga-

* Verheyen, Anat. trac. 5. cap. 9.—Sue Trad. d'osteol, p. 137.

mentous membrane stretched over it, which, with the muscles that cover it, and are very prominent on each side, is a sufficient defence for the bundle of nerves within.

In some cases there is only one spinous process, or the whole canal is open behind in the adult; hence the great danger that may result from a wound with a sharp pointed instrument near to the end of the sacrum. I have seen the upper part of the spinal canal of the os sacrum open while the under part was shut, as in the Australasian.

Foramina.—At the root of each oblique process of this bone, the notch, meeting with another similar to it, is opposed to a similar notch in the last vertebra of the loins: thus a passage is left for the *twenty-fourth spinal nerve:* the os sacrum, before or behind, has four large holes in each side, placed at the same height. Some of the *largest nerves of the body* pass through the anterior holes; and superficial grooves running outwards from them in different directions, indicate the course of these nerves.

Between these grooves the pyriformis muscle chiefly rises. The holes in the back part of the bone are covered by membranes through which small nerves pass.

The two uppermost of these holes, especially on the fore side, are the largest. Sometimes a notch only is formed at the lower part in each side of this bone; and in other subjects there is a hole common to it and the os coccygis, through which the twenty-ninth pair of spinal nerves passes.

The upper part of the body of the first bone resembles the vertebræ *of the loins;* but the small fifth bone is oblong transversely, and hollow in the middle of its lower surface.

The substance of the os sacrum is very spongy, and is proportionally lighter to its bulk than any other bone in the body. This bone is well protected from external injury, by the thick muscles that cover it behind, and by the strong ligamentous membranes.

This bone is articulated above to the last vertebra *of the loins*, in the manner that the lumbar vertebræ are joined; and therefore the same motions may be performed here.

The articulation of the lower part of the os sacrum to the

os coccygis admits of considerable motion. Laterally, the os sacrum is joined to the ossa ilia by an *immoveable* synchondrosis: the cartilaginous crust on the surface of the bones is very thin, and both their surfaces are scabrous and unequal, and indented into each other; and the connexion between the bones is so intimate, that great force is required to separate them, after all the muscles and ligaments are cut. Frequently the two bones grow together in old subjects.

State at Birth.—The bones composing the os sacrum of infants, are separated from each other by a thick cartilage; and, like the true vertebræ, each of them consists of a body and two lateral plates, connected together by cartilages; the ends of the plates seldom being contiguous behind.

In consequence of the imperfect ossification of the os sacrum, there is sometimes an aperture in it through which the rectum protrudes M. Lacoste has described to the Royal Medical Society of Toulouse, a case of what he has called a Sacro-rectal Hernia. There was a tumour in the middle and posterior part of the os sacrum of the size of a walnut, an inch and a half above the anus, which received an impulse when the child cried, and which could be reduced; upon which being done, the fæces were discharged with force from the anus.

Os Coccygis *.

Os Coccygis, or rump-bone, is that triangular chain of bones appended to the os sacrum.

The os coccygis is convex behind, and concave before; which crooked pyramidal figure renders it somewhat similar in form to a cuckow's beak.

This bone consists, in middle life, of four pieces, which are of unequal size; and the largest is fixed to the smaller end of the os sacrum. In children, very near the whole of it is cartilage: In old subjects, all the bones are united, and become frequently one continued bone with the os sacrum.

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* Ὀρρόπυγιον, ὀρρός, caudæ os, spondylium, os cuculi.

The shoulders of the largest piece are extended beyond the end of the os sacrum; which enlargement should, in my opinion, serve as a distinguishing mark to fix the limits of either bone. From the back of its *shoulders*, a process often rises up on each side, which join with the bifurcated spine of the fourth and fifth bones of the os sacrum, to form the bony bridge mentioned in the description of the os sacrum. Sometimes these shoulders are joined to the sides of the fifth bone of the os sacrum, to form the hole in each side common to these two bones, for the passage of the twenty-ninth pair of spinal nerves. Immediately below the shoulders of the os coccygis, a notch may be remarked in each side, where the thirtieth pair of the spinal nerves passes. The lower end of this bone is formed into a small head, which very often is hollow in the middle.

The three lower bones gradually *become smaller, are spongy*, and are strengthened by a strong ligament which covers and connects them.

Between each of these four bones in young subjects, a cartilage is interposed. The lower end of the os sacrum, and of each of the three superior bones of the os coccygis, has a small depression in the middle; and the upper part of all the bones of the os coccygis is a little concave, and, consequently, the interposed cartilages, connecting these bones, are thickest in the middle, to fill up both cavities; thus the bones are more firmly fixed to each other. When the cartilages ossify, the upper end of each bone is formed into a cavity, exactly adapted to the protuberant lower end of the bone immediately above.

From this sort of articulation, it is evident, that, unless when these bones grow together, all of them are capable of motion; of which, the first and second, especially this last, enjoys the largest share.

The lower end of the fourth bone terminates in a rough point, to which a cartilage is appended.

To the sides of these bones of the os coccygis, the coccygæi muscles, and part of the levatores ani, and of the glutæi maximi, are fixed.

The substance of these bones is very spongy, and in chil-

dren cartilaginous; there being only a part of the first bone ossified in a new-born infant. Since, therefore, the intestinum rectum of children is not so firmly supported as it is in adults, this may be one reason *why they are more subject to a procidentia ani* than old people *.

The ligaments proper to the ossa coccygis admit of these bones being drawn backwards to a considerable extent, which, by enlarging the under aperture of the pelvis, facilitates the expulsion of the contents of the rectum, and also labour; hence, when these ligaments are converted into bone, as often happens in advanced life, labour is rendered difficult.

The ossa coccygis being bended forwards, are well calculated for supporting the rectum, whilst the soft parts, which covers these, are not injured in sitting, when the body is inclined backwards: and it may be added that the encurvature of the os sacrum and ossa coccygis is peculiar to man.

Ossa Innominata.

The two large broad and irregularly formed bones called Ossa Innominata, constitute the fore part and sides of the pelvis, and the lower part of the sides of the abdomen.

Each of these bones of the fœtus consists of three bones, to-wit, the os ilium, ischium, and pubis.

Os Ilium.

The Os Ilium †, or haunch-bone, is situated highest of the three, and reaches as far down as one-third of the great cavity into which the head of the thigh-bone is received.

The external side of this bone is unequally convex, and is called its dorsum;—the internal concave surface is by some (but improperly) named its costa.

The semicircular edge at the highest part of this bone, which is tipped with a cartilage in the recent subject, is named the spine, into which the external or descending oblique muscle of the abdomen is inserted; and from it the internal as-

* Spigel. de Humani corp. fabric. lib. 2. cap. 22.—Paaw de ossib. par. 2. cap. 3.

† Αἀγὸναν, κενεαν, scaphium, lumbare, clunium, clavium, anchas.

cending oblique, and the transverse muscles of the belly, with the glutæus maximus, quadratus lumborum, and latissimus dorsi, have their origin.

The ends of the spine are more prominent than the surface of the bone below them; therefore are reckoned processes.

From the anterior spinal process, the sartorius and tensor vaginæ femoris muscles take their rise, and the outer end of the doubled tendon of the external oblique muscle of the abdomen, commonly called Fallopius's or Poupart's Ligament, or Crural Arch, is fixed to it.—The inside of the posterior spinal process, and of part of the spine forward from that, is made flat and rough, where the sacro-lumbalis and longissimus dorsi rise; and to its outside are fixed ligaments, extended to the os sacrum and transverse processes of the fifth and fourth vertebræ of the loins *.

Below the anterior spinal process another protuberance stands out, which, by its situation, may be distinguished from the former, by adding the epithet of *inferior*, from which the rectus cruris † has its origin ‡.

Besides these two anterior processes, the bone is hollowed where the beginning of the sartorius muscle is lodged. Below the posterior spinal process, a second protuberance of the edge of this bone is in like manner observable, which is closely applied to the os sacrum. Under this last process there is a large niche in the os ilium; between the sides of which, and the strong ligament that is stretched over from the os sacrum to the sharp-pointed process of the os ischium of the recent subject, a large hole is formed, through which the musculus pyriformis, the great sciatic nerve, and the posterior crural vessels pass, and are protected from compression.

The external broad side or dorsum of the os ilium is a little hollow towards the fore-part; farther back it is as much raised; then is considerably concave; and, lastly, it is convex. These inequalities are occasioned by the actions of the muscles that are situated on this surface.

From behind the uppermost of the two anterior spinal pro-

* Weitbrecht, Syndesmolg. sect. 4, § 39, 40, 46, 47.

† Rectus cruris, Alb. ‡ Baker, Curs. osteolog. demonstr. 3.

cesses, in such bones as are strongly marked by the muscles, a semicircular ridge is extended to the hollow passage of the sciatic nerve. Between the spine and this ridge, the glutæus medius takes its rise. Immediately from above the lowest of the anterior spinal processes, a second ridge is stretched to the niche. Between this and the former ridge, the glutæus minimus has its origin. On the outside of the posterior spinal processes, the dorsum of the os ilium is flat and rough, where part of the musculus glutæus maximus and pyriformis rise. The lowest part of this bone is the thickest, and is formed into a large cavity with high brims, to assist in composing the great acetabulum; which shall be considered, after all the three bones that constitute the os innominatum are described.

The internal surface of the os ilium is concave in its broadest fore part, and gives rise to the internal iliac muscle, and also lodges and supports a part of the intestinum ilium and colon.

From this large hollow, a small sinuosity is continued obliquely forwards, at the inside of the anterior inferior spinal process, where part of the psoas and iliacus muscles, with the crural vessels and nerves, pass. The large concavity is bounded below by a sharp ridge, which runs from behind forwards; and, being continued with such another ridge of the os pubis, forms a line of partition between the abdomen and pelvis. Into this the broad tendon of the psoas parvus is inserted.

The internal surface of the os ilium, behind this ridge, is very unequal: For the upper part is flat, but spongy, where the sacro-lumbalis and longissimus dorsi rise.

Lower down there is a transverse ridge, from which ligaments go out to the os sacrum. Immediately below this ridge, the rough unequal cavities and prominences are placed, which are exactly adapted to those described on the side of the os sacrum.

The upper part of this rough surface is porous, for the firmer adhesion of the ligamentous cellular substance; while the lower part is more solid, and covered with a thin cartilaginous skin, for its immoveable articulation with the os sacrum.

From the circumference of this large unequal surface, ligaments are extended to the os sacrum, to secure more firmly the conjunction of these bones.

The passages of the medullary vessels are generally conspicuous, both in the dorsum and costa of many ossa ilia.

The posterior and lower parts of these bones are thick; but they are generally exceedingly thin and compact, at their middle.

The substance of the ossa ilia is cellular, except a thin external table.

The spine of the os ilium of a child is cartilaginous, and is afterwards joined to the bone in form of an epiphysis *. The large lower end of this bone is not completely ossified.

Os Ischium.

The os ischium, or hip-bone, *is of a middle bulk between the two other parts of* the os innominatum; is situated lowest of the three, and is of a very irregular figure.

Its extent might be marked by an horizontal line drawn nearly through the middle of the acetabulum; for the upper bulbous part of this bone forms somewhat less than the lower half of that great cavity, and the small leg of it rises to much the same height on the other side of the great hole common to this bone and the os pubis.

Processes.—A sharp process, called by some spinous, stands out backwards, from the upper part of the os ischium, which gives rise to the musculus coccygæus and superior gemellus, and part of the levator ani; and the interior or internal sacro-sciatic ligament is fixed to it.

Between the upper part of this ligament and the bones, the pyriform muscle, the posterior crural vessels, and the sciatic nerve, pass out of the pelvis. Immediately below this process, a sinuosity is formed for the tendon of the musculus obturator internus. In a recent subject, this part of the bone, which serves as a pully on which the obturator muscle plays,

* Vid. Albinus's tables of the bones of the fœtus.

is covered with a ligamentous cartilage. The outer surface of the bone at the root of this spinous process is made hollow by the pyriformis or iliacus externus muscle.

Below the sinuosity for the obturator muscle, is the great knob or tuberosity, covered with cartilage or tendon *. The upper part of the tuberosity gives rise to the inferior gemellus muscle. To a ridge at the inside of this, the posterior sacro-sciatic ligament is so fixed, that between it the internal ligament, and the sinuosity of the os ischium, a passage is left for the internal obturator muscle. The upper thick smooth part of the tuber, called by some its dorsum, has two oblique impressions on it. The inner one gives origin to the long head of the biceps flexor cruris and semitendinosus muscles, and the semimembranosus rises from the exterior one, which reaches higher and nearer the acetabulum than the other.

The lower, thinner, more scabrous part of the knob which bends forwards, is also marked with two flat surfaces, whereof the internal is what we lean upon in sitting, and the external gives rise to the largest head of the triceps adductor femoris.

Between the external margin of the tuberosity and the great hole of the os innominatum, there is an obtuse ridge extended down from the acetabulum, which gives origin to the quadratus femoris. As the tuber advances forwards, it becomes smaller, and is rough, for the origin of the transverse muscle of the perinæum and erector penis.

The small leg of it, which mounts upwards to join the os pubis, is rough and prominent at its edge, where the two lower heads of the triceps adductor femoris take their rise.

The upper and back part of the os ischium is broad and thick; but its lower and fore part is narrower and thinner. Its substance is of the structure common to broad bones.

The part of the os ischium which forms the acetabulum, the spinous process, the great tuber, and the recurved leg, are all cartilaginous at birth. The tuber, with part of the

* Winslow, Exposit. Anat. des os frais, § 96.

leg or process above it, becomes an epiphyse before this bone is fully formed.

Os Pubis.

The *Os Pubis*, *, or share-bone, *is the least* of the three parts of the os innominatum, and is placed at the upper fore part of it.

The thick largest part of this bone forms a part of the acetabulum; from which becoming much smaller, it is stretched inwards to its fellow of the other side, where again it grows larger, and sends a small branch downwards to join the end of the small leg of the os ischium.

The upper fore part of each os pubis is tuberous and rough, and gives insertion to the musculus rectus and pyramidalis. From this a ridge is extended along the upper edge of the true pelvis, in a continued line with such another of the os ilium, which divides the abdomen and pelvis. This ridge is called Linea Ileo-Pectinea.

The ligament of Fallopius, or *crural arch*, is fixed to the internal end of this ridge, and the smooth hollow below it, is made by the psoas and iliacus internal muscles passing with the anterior crural vessels and nerves behind the ligament. Some way below the former ridge, another is extended from the tuberous part of the os pubis downwards and outwards towards the acetabulum: between these two ridges the bone is hollow and smooth, for lodging the head of the pectineus muscle.

Immediately below, where the lower ridge is to take the turn downwards, a winding niche is made, which is comprehended in the great foramen of a skeleton, but is formed into a hole by a subtended ligament in the recent subject, for the passage of the posterior crural nerve, an artery, and a vein.

The edges of the descending portions of the ossa pubis are, more especially in the male, prominent, and folded backwards. In the Negro this prominence is very conspicuous, and, together with the very prominent tuber ischii, forms a very distinguishing feature of the pelvis in that race.

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*Ἡβὸς, pectinis, penis, pudibundum, fenestratum.

The internal extremity of the os pubis is rough and unequal, for the firmer adhesion of the thick ligamentous cartilage that connects it to its fellow of the other side: The process which goes down from that to the os ischium, is broad and rough before, where the gracilis and upper heads of the triceps, or rather quadriceps adductor femoris, have their origin. It may also be added, that the ossa pubis, immediately beneath the symphysis, are sometimes depressed to a remarkable degree for the space of about 2 inches square.

The substance of the os pubis is the same as of other broad bones.

State at Birth.—In a child born at the full time, a part only of the large end of this bone is ossified, and the whole leg is cartilaginous. In some females, a small bone, in a state of epiphysis, is connected with the spine of the pubis; this bone is quite moveable.

Thyroid hole.—Betwixt the os ischium and pubis, a very large irregular hole is left, which, from its resemblance to a door or shield, has been called *thyroides.* This hole is, except the niche for the posterior crural nerve, filled up in a recent subject with a strong ligamentous membrane, that adheres very firmly to its circumference. Thus the pelvis is rendered much lighter, and sufficient space is given for the origin of the external and internal obturator muscles.

The bowels sometimes make their way through the foramina obturatoria. This kind of hernia is often not distinguished till after death, on account of the deep situation of the tumour, and its small size, for it is prevented from extending by the 1st and 2d heads of the triceps muscle.

In the external surface of the ossa innominata, near the outside of the great hole, a large deep cavity, called Acetabulum, is formed, by all the three bones conjunctly: For the os pubis constitutes about one-fifth; the os ilium makes something less than two-fifths, and the os ischium as much more than two-fifths. For the sake of additional security this cavity is of considerable depth, especially at its upper back part; and, besides, in the recent body, it has a broad border and

cartilage. This is very necessary to prevent the head of the femur from slipping out of its cavity at this place, where the whole weight of the body bears upon it.

Notwithstanding this provision against dislocation, the head of the thigh bone is sometimes thrust upwards and backwards upon the dorsum of the os ilium. At the internal lower part of the acetabulum there is a breach in the bone, across which a *ligament* is placed in the recent subject; under which a large hole is left, which contains fat, cellular substance and vessels. This seems intended for admitting of more extensive motion to the thigh inwards: For if the bony brims had been perfect, the neck of the thigh-bone must have struck upon them, when the thighs were thrown across each other. The lower internal part of the acetabulum is depressed below the cartilaginous surface of the upper part, and is not covered with cartilage; into the upper part of this particular depression, where it is deepest, and of a semilunar form, the ligament of the thigh-bone, commonly, though improperly, called the round, is inserted.

It seems necessary to add a few remarks upon the manner in which the bones of the pelvis are connected to each other.

There is one part of the os sacrum that is covered with a cartilage, and which corresponds exactly to a portion of the surface of the os ilium, and which, in the recent subject, is actually glued to it; so that though the capsular ligament be divided, the os innominatum cannot be separated from the os sacrum, without using considerable force.

Owing to the extent of this surface, and the general shape of the os sacrum and ossa innominata, these bones are almost immovrable. There is something altogether singular in the connexion of these bones, much more if the sacrum is included within the capsular ligaments. There is a space between these, which is filled with a red fibrous substance, which does not bear a resemblance to any other part of the human frame. In short, judging from the structure, there can be no great degree of motion between the bones of the pelvis, without a disease, and such a separation as would be very sensibly

felt after delivery, and which could not fail to be a source of great uneasiness.

There occurs no doubt after delivery, in some cases, somewhat of a relaxation, from the pressure of the uterus upon the returning veins, and from the mechanical force of the head of the child acting like a wedge against these joints.

Upon this point there is much contrariety of opinion, and it may not be improper to put the reader in possession of the opinions of some of the most distinguished writers upon this head.

My grandfather had collected the sentiments of the older authors on this head in an unpublished manuscript, of which the subjoined is an extract.

"Bauhinus mentions two examples; one of them a woman 24 years of age, who was hanged at Paris, ten days after she had been delivered of a child. When either of the legs of the corpse was raised, the os pubis of that side started half an inch higher than the other one; and this, he says, they did alternately, to show the loose connection of the bones of the pelvis. He tells us, that Pinæus who was present gives a full account of this experiment. Bauhinus further says, that he saw the same thing in a lady who had died undelivered of the placenta. He then quotes Fernelius, Silvius, and a great many other writers, who assert that this relaxation happens. Spigelius affirms that he has seen the os pubis of the old, where the leg was raised, to stand up an inch; but is of opinion that this relaxation only happens in tedious hard labour. Riolan seems to think that a relaxation generally happens, and affirms that he demonstrated it more than thirty times to Physicians and Surgeons, and particularly relates what he says he shewed to above three hundred spectators in the public dissection of the body of a woman who was hanged four days after having borne a child.

"In her the cartilage between the ossa pubis was relaxed an inch, and the conjunction of the ossa ilium with the os sacrum was so loose, that he easily separated them with a thin scalpel. Instead of cartilage interposed between these bones, there was a thick red-coloured ligament. Diemenbroek only

saw the relaxation once in the body of a woman who died two days after her delivery. He thinks that this only happens in laborious birth. He gives a list of a great many authors who are of different opinions on this question.

" Hildanus asserts that he could never observe the disjunction of the ossa pubis, though he was most frequently employed in most laborious and difficult births, and endeavoured to examine this fact with all the care he could. Dionis says in strong terms that there is no separation of these bones in the birth of a child; adding, that he had opened and dissected many women who were very lately brought to bed. Morgagni thinks that the relaxation sometimes happens, but that it is not the common tenor of nature.

" When one examines the connection of the bones of the pelvis of a woman, who has not lately borne a child, it might be thought almost impossible that any force of child-bearing could make them recede from each other. But, it is to be considered, that in labour, especially when it is tedious, there is a great flow of mucus to all the parts of the pelvis. One of the surest signs which several women have of their bearing pains being soon to come on, is a watery swelling of the labia pudendi, and a dribbling of mucus from the vagina. The reason of this overflowing of liquors here at the time of birth is, the child, when it falls down towards the os uteri, pressing the lower part of the womb against the sides of the pelvis, by which the vessels there are compressed. The arteries continue, notwithstanding the pressure, to drive forwards the blood, but the return of it by the veins is difficult; this resistance to the returning blood causes the small arteries to infuse the thin parts of it into the substance and cavities of all the parts, in the same way as we see a leg or arm made monstrously œdematous by a pressure on the iliac or axillary veins."

The same difference of opinion prevails amongst more modern authors; thus, Desault, Boyer, Chaussier, and Piet, speak of the disunion of the bones of the pelvis, and the latter author has imputed it to a swelling of the cartilages, and the extension of the ligaments.

Baudelocque, on the other hand, supposes the relaxation of

the bones to arise solely from the relaxation of the ligaments. Most English authors on Midwifery, are of opinion that there is no separation of the bones during labour. If there had been a separation of the bones of the pelvis, even the raising the one thigh above the other must have created pain, and the patient could not have walked for a considerable time; and if complete disunion had taken place, it might be perceived by the jarring created by grasping between the fingers the symphysis pubis, and raising the thigh. From the number of specimens of anchylosis of the symphysis pubis, and also, at the sacro-iliac symphysis, in the Museum of the University, I am led to conclude, that an inflammation of these joints is no unfrequent sequel of the pregnant state, which inflammation has probably occasioned the anchylosis.

Writers on Midwifery make mention of this inflammatory state, which may be distinguished by acute pain in the lower part of the belly, increased on motion, by deranged state of the alimentary canal, and by the accession of fever.

Of the Pelvis of the Fœtus.

The form of the cavity of the pelvis of the infant is widely different from that of the adult, for the longest diameter is between the os sacrum and the symphysis pubis.

About the period of puberty, the oblique and lateral diameters are equal.

In very early life the pelvis somewhat resembles a cone, of which the coccyx and tuberosities of the ischia form the apex, and the ilium the base, or the proportions of the infant pelvis are precisely opposite to those of the pelvis of the adult.

The bladder of urine of the fœtus may be said to be in part lodged within the abdomen, and also that portion of the larger intestine which has commonly been called intestinum rectum. There is a circumstance which I observed respecting that bowel, which I believe has escaped the notice of anatomists; that the intestinum rectum of a young fœtus does not so exactly as in the adult follow the sweep of the os sacrum, for the lower half of it forms a portion of a semicircle, the convexity of which is towards the bladder of urine.

Lastly, The axis of the pelvis of the fœtus is different from that of the adult: hence Dr Camper has justly observed, "si ad directionem attendemus eam in adultis, antrorsum inclinari, in infantibus propter spinæ rectitudinem cum lineo propensiores fere concidente comperiemus; hinc manifestum est, coxas ejus qui calcule sectione subiturus est, pro diversa ætate, collocari debemus elevatius in juniori, humilius in adultis."

Of Deficiency at the fore part of the Pelvis.

There are a few instances on record *, (I have seen three such), in which there has been a deficiency in the male pelvis at the symphysis pubis, and in which the pelvis is at the same time as broad as the female pelvis, so that the gait of the individual is like to that of a woman.

The first instance I saw was in the person of a man of 30 years of age, who was of middle stature, rather corpulent, and who seemed to enjoy good health. He had in the region of the pubis a red-coloured swelling, about the size of an orange, which had a glossy surface, and which was constantly kept moist by a fluid, discharged from a couple of orifices, which opened on the surface of the tumour, and into these a probe might be entered for several inches. The fluid was discharged drop by drop, and had all the characters of the urine.

About an inch below this red-coloured tumour, there was a smaller projecting body, about an inch and a half long, and about an inch in breadth, on the upper surface of which there was a distinct groove, but there was no canal, like the urethra, in the under part of it: the front of this body somewhat resembled the glans penis, and had something like a prepuce.

Beneath this body, the scrotum containing the testes, which were of the usual size, was placed.

In short, in this instance the back part of the bladder had been protruded, and the openings above described were the terminations of the ureters.

* See Transactions of a Society for the improvement of Medical and Surgical Knowledge, vol. i. p. 90.

The subject of this malconformation informed me, that when in female society the penis was frequently erected.

I have seen two children with similar malconformations.

CHAP. VIII.

OF THE THORAX.

THE *thorax*, or *chest*, reaches from below the neck to the belly; and, by means of the bones that guard it, is formed into a large cavity: the figure of which is somewhat conchoidal, with its upper smaller end left open for the passage of the windpipe, gullet, and large bloodvessels: its lower part, or base, has no bones, and is shorter before than behind; so that it is like to an oblique section of the conchoid. The lower part of this cavity is narrower than some way above *; and the middle of its back part is considerably diminished by the projection of the spine.

The figure of the thorax is very various, corresponding with that of the included parts. Hence it may be partially or generally deformed by diseases of the heart, and great vessels connected with it, or by those of the lungs, liver or spleen; by the unnatural accumulation of fluids within the pleuræ, or belly; or by pressure applied externally, which, by forcing the ribs inward, and, by interrupting the functions of the contained viscera, often lays the foundation of bad health.

In the rickety skeleton, the ribs are much flattened. I have seen them concave, instead of being convex, outwardly.

The female chest is shorter and broader than that of the male.

* Albin. de Ossib. § 169.

The bones of the thorax are the *twelve dorsal vertebræ* behind, *the ribs* on the sides, and *the sternum* before.

The *ribs*, or *costæ* *, are long crooked bones placed at the side of the chest, and obliquely downwards, in respect to the back-bone. Their number is generally twelve on each side; though frequently eleven or thirteen have been found †. Sometimes the ribs are found preternaturally conjoined or divided ‡.

The ribs are concave and smooth internally, but convex externally, that they might resist that part of the pressure of the atmosphere which is not balanced by the air within the lungs during inspiration.

The ribs are commonly divided into 7 *true* and 5 *false*, or into vertebral and sterno-vertebral.

The breadth of the ribs differs very much in different persons, and in different nations. In very tall men I have noticed that the ribs are of much greater proportional breadth than in shorter persons; and in some of the inhabitants of the north, the ribs are remarkable for their breadth, whilst those of the New Hollander are unusually slender.

No more space is left between the ribs than is sufficient for the intercostal muscles, and the ends of the ribs next the vertebræ are rounder than they are after these bones have advanced forwards, when they become flatter and broader, and have an upper and lower edge, each of which is made rough by the action of the intercostal muscles, inserted into them. The muscles between the ribs being of nearly equal force, and equally stretched, keep the broken ends of these bones, when fractured, from crossing each other.

The upper edge of the ribs is more obtuse and rounder than the lower, which is depressed on its internal side by a long fossa, for lodging the intercostal vessels and nerves; on each side of which there is a ridge to which the intercostal muscles are fixed. The fossa is not observable, however, at either end of the ribs; for at the posterior or root, the vessels

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* Πλευραὶ, περιστέρνα, σπάζαι.

† Riolan Comment. de Ossib. cap. 19. Marchetti, cap. 9. Cowper Explicat. tab. 93. and 94. Morgagn. Advers. anat.

‡ Sue Trad. d'Osteolog. 141.

have not yet reached the ribs ; and, at the fore end, they are split away into branches : hence the greater safety of performing the operation for the empyema towards the sides of the thorax, than either near the back or the breast.

At the posterior end of each rib, a little head is formed, which is divided by a middle ridge into two plane or hollow surfaces ; the lowest of which is the broadest and deepest in most of them. The two planes are joined to the bodies of two different vertebræ, and the ridge forces itself into the intervening cartilage. Round the head, the bone appears spongy, where the capsular ligament of the articulation is fixed. Immediately beyond this a flatted tubercle rises, with a small cavity at, and roughness about its root, for the articulation of the rib with the transverse process of the lowest of the two vertebræ, with the bodies of which the head of the rib is joined. Advancing further on this external surface, we observe in most of the ribs another smaller tubercle, into which the ligaments, which connect the ribs to each other, and to the transverse processes of the vertebræ and portions of the longissimus dorsi, are inserted. Beyond this the ribs are made flat by the sacro-lumbalis muscle, which is inserted into the part of this flat surface farthest from the spine, where each rib makes a considerable curve, called by some its *angle*. Then the rib begins to turn broad, and continues so to its anterior end *, which is hollow and spongy, for the reception of, and firm coalition with, the cartilage that runs thence to be inserted into the sternum, or to be joined with some other cartilage.

In adults generally, the cavity at this end of the ribs is smooth and polished on its surface ; by which the articulation of the cartilage with it has the appearance of being designed for motion ; but it has none.

The substance of the ribs is spongy, cellular, and only covered with a very thin external lamellated surface, in which the fibres are more distinct than in most other bones, and which increases in thickness and strength as it approaches

* Πλάτη, Palmula.

the vertebræ. In the *rickets, these spongy anterior ends of the ribs swell;* hence the sternum appears to be more depressed than it really is.

To the fore end of each rib, a long broad and strong cartilage is fixed, and reaches thence to the sternum, or is joined to the cartilage of the next rib. This course, however, is not in a straight line with the rib; for generally the cartilages make a considerable curve, the concave part of which is upwards; therefore, at their insertion into the sternum, they make an obtuse angle above, and an acute one below.

These cartilages are of such a length, as never to allow the ribs to come to a right angle with the spine; but keep them situated so obliquely, as to make an angle very considerably obtuse above, till a force exceeding the elasticity of the cartilages is applied. These cartilages, as all others, are firmer and harder internally, than they are on their external surface; and sometimes, in old people, their middle substance becomes bony, while a thin cartilaginous lamella appears externally *. The ossification, however, begins frequently at the external surface. The greatest alternate motions of the cartilages being made at their great curvature, that part remains frequently cartilaginous after all the rest is ossified †.

The ribs are articulated at each end, of which the one behind is doubly joined to the vertebræ; for the head is received into the cavities of two bodies of the vertebræ, and the larger tubercle is received into the depression in the transverse process of the lower vertebra. This double articulation admits of motion upwards and downwards only, since the transverse process hinders the rib to be thrust back; the resistance on the other side of the sternum prevents the rib coming forward; and each of the two joints with the other parts attached oppose its turning round. It is likewise evident, that even the motion upwards and downwards can be but small in any one rib at the articulation itself. But as the ribs advance forwards, the distance from their centre of mo-

* Vesal. lib. 1. cap. 19.

† Havers, Osteolog. nov. Disc. 5. p. 289.

tion increasing, the motion must be more extensive; and it would be very conspicuous at their anterior ends, were not they resisted there by the cartilages, which yield so little, that the principal motion is performed by the middle part of the ribs, which turns outwards and upwards, and occasions the twist remarkable in the long ribs at the place near their fore end, where they are most resisted *.

Of the Peculiarities of the Ribs.

In viewing the ribs from above downwards, their figure is still straighter; the uppermost being the most crooked of any. Their obliquity, in respect of the spine, increases as they descend; so that though their distances from each other is very little different at their back part, yet at their fore ends the distances between the lower ones must increase. In consequence of this increased obliquity of the lower ribs, each of their cartilages makes a greater curve in its progress from the rib towards the sternum; and the tubercles, that are articulated to the transverse processes of the vertebræ, have their smooth surfaces gradually facing more upwards. From the ribs becoming thus more oblique, while the sternum advances forwards in its descent, the distance between the sternum, and the interior end of the lower ribs, is greater than between the sternum and the ribs above; consequently the cartilages of those ribs that are joined to the breast-bone are longer in the lower than in the higher ones. These cartilages are placed nearer to each other as the ribs descend, which occasions the curvature of the cartilages to be greater. My Father, in his treatise on the many advantages which result from the obliquity of the intercostal muscles, has been at great pains in representing the peculiarities as to the form of the ribs, and of their cartilages †.

The length of the ribs increases from the first and uppermost rib, as far down as the seventh; and from that to the twelfth as gradually diminishes.

The superior of the two plain, or rather hollow surfaces,

* Winslow, Memoires de l'Acad. des Sciences, 1720.

† Vide Edin. Phil. Trans vol. iii.

by which the ribs are articulated to the bodies of the vertebræ, gradually increases from the first to the fourth rib, and is diminished after that in each lower rib.

The distance of their angles from the heads always increases as they descend to the ninth, on account of the greater breadth of the sacro-lumbalis muscle *.

The cartilages of the true ribs become gradually longer as the ribs descend, and are joined to the breast-bone; so that being pressed constantly between two bones, they are thicker, harder, and more liable to ossify, than the cartilages of the other ribs.

The cartilages of five inferior ribs of each side do not reach to the sternum; and therefore, wanting the resistance at their fore part, they are pointed. The cartilages of these false ribs are shorter as the ribs descend. To all these five ribs the circular edge of the diaphragm is connected; and its fibres, instead of being stretched immediately transversely, and so running perpendicular to the ribs are pressed so as to be often, especially in expiration, parallel to the plane in which the ribs lie: Nay, one may judge by the attachments which these fibres have so frequently to the sides of the thorax, a considerable way above where their extremities are inserted into the ribs, and by the situation of the viscera, always to be observed in a dead subject laid supine, that there is constantly a large concavity formed on each side by the diaphragm within these bastard ribs, in which the stomach, liver, spleen, &c. are contained.

The cartilages connecting the ribs to the breast-bone have sometimes been separated from it; and sometimes, but more rarely, from the extremities of the ribs, by external violence.

My Father discovered, that the cartilages between the ribs and the breast-bone, with the exception of the cartilage of the first rib, are not fixed to the sternum in the same manner as to the ribs; for the rib which is hollowed receives the cartilage, and is so firmly united to it, that, in the recent subject, they cannot be separated without lacerating the cartilage;

* Winslow, Exposition Anatomique des Os Secs, § 645.

but the inner part of the cartilage is tied by a capsular ligament to the edges of the pit of the sternum, and the concave part of the pit is connected, by fine cellular threads, only to the end of the cartilage, so that the cartilage and sternum, may, after cutting the capsular ligament, be separated from each other, *without tearing the cartilaginous fibres.* Hence, when the ribs are moved, the capsular ligament is twisted, and the end of the cartilage rolls upon the sternum *.

The first rib of each side is so situated, that the flat sides are above and below, while one edge is placed inwards, and the other outwards, or nearly so; therefore sufficient space is left above it for the subclavian vessels and muscle; and the broad concave surface is opposed to the lungs: In consequence of this situation, the channel for the intercostal vessels is not to be found, and the edges are differently formed from all the other, except the second; the lower one being rounded, and the other sharp.

The head of this rib is not divided into two plane surfaces by a middle ridge, because it is only articulated with the first vertebra of the thorax. Its cartilage is ossified in adults, and is united to the sternum at right angles.

Frequently this first rib has a ridge rising near the middle of its posterior edge, where one of the heads of the scalenus muscle rises. Farther forward it is flattened, or sometimes depressed, by the clavicle.

The cartilages of the fifth, sixth, and seventh, or rather the sixth, seventh, eighth, and sometimes the fifth, sixth, seventh, eighth, ninth ribs †, are contiguous; and frequently they are joined to each other by cross cartilages; and most commonly the cartilages of the eighth, ninth, tenth, are connected to the former, and to each other by firm ligaments.

The eleventh, and sometimes the tenth rib, has no tubercle for its articulation with the transverse process of the vertebra, to which it is only loosely fixed by ligaments. The

* Vide Observations on the Oblique Muscles, Edin. Phil. Trans. vol. 3.

† Vide plate 4th appended to my Father's *Treatise on the Oblique Muscles*, which represents the lengths and curvatures of the seven uppermost ribs and their cartilages. Ed. Phil. Trans. vol. iii.

The fossa, in its lower edge, is not so deep as in the upper ribs, because the vessels run more towards the interstice between the ribs. Its fore end is smaller than its body, and its short small cartilages are but loosely connected to the cartilage of the rib above.

The twelfth rib is the shortest and straightest. Its head is only articulated with the last vertebra of the thorax; therefore is not divided into two surfaces.

This rib is not joined to the transverse process of the vertebra, and therefore has no tubercle, being often pulled necessarily inwards by the diaphragm, which an articulation with the transverse process would not have allowed.

The fossa is not found at its under edge, because the vessels run below it.

The fore part of this rib is smaller than its middle, and has only a very small pointed cartilage fixed to it. To its whole internal side the diaphragm is connected.

The heads and tubercles of the ribs of a new born child have cartilages on them; part of which become afterwards thin epiphyses. The bodies of the ribs encroach gradually after birth upon the cartilages; so that the latter are proportionally shorter, when compared to the ribs, in adults, than in children.

The provident care of our CREATOR, in preserving us from perishing as soon as we come into the world, by completing before birth the ossification of *the condyles of the occipital bone of the lower jaw, and the heads and tubercles of the ribs*, merits particular mention: hence the weight of the large head is firmly supported; the actions of sucking, respiration, &c. which are indispensably necessary to life, are performed without danger of separating the parts of the bones that are most pressed on in these motions: whereas, had these processes of the head, jaw, and ribs, been epiphyses at birth, children must have been exposed to danger of dying by such a separation; the immediate consequences of which would be the compression of the beginning of the spinal marrow, or want of food, or a stop put to respiration.

As the ribs are in contact with the lungs, when one or more

of these is broken and beaten inwards, they may perforate the lungs, whereby the air within the lungs may escape by the aperture made in the pleura into the sac of the pleura of that side. The air may also escape into the subcutaneous cellular substance.

The escape of the air from the lungs compresses these, impedes respiration, creates a sense of tightness across the chest, which is speedily followed by great oppression in the breathing, especially in the recumbent posture, by feebleness of pulse, which becomes very irregular, by coldness of the extremities, and (if relief be not speedily administered) by death. My Father had an opportunity of examining the bodies of some patients who had died from the above cause; and, on puncturing the chest, such a blast of air issued forth, as blew out a candle several times: on exposing the thorax fully, the lungs on the same side were found collapsed, and occupying the upper part of the chest: the diaphragm was forced downwards in an unnatural manner.

When the air has got at the same time into the subcutaneous cellular membrane, the skin is inflated, and raised up from the subjacent bones; the patient looks like a stuffed person, whose bones had been taken out: when pressure is made, the air is forced from one part of the body to another, and a sensation such as pressing on a dried bladder would give, is communicated, and a crackling noise is at the instant perceptible.

Mr B. Bell, in treating of this subject * has stated. "Till of late, patients in this situation almost constantly died; for when scarifications failed in discharging the air, and even this remedy has not been long in use, practitioners were not acquainted with any other mode of relief." He adds, "It (the operation of paracentesis of the thorax) has accordingly been frequently performed, and always with complete success."

"This operation for the evacuation of air from the chest, was first proposed by Dr Monro about the year 1760, in his Lectures in this University."

* Vide his System of Surgery, vol. v. 6th Edit. pp. 233--4.

Sternum.

The STERNUM *, or breast-bone, is a flat bone and pile of bones: it varies considerably as to breadth in different persons, and is placed at the fore part of the thorax. In adults of a middle age, it is composed of three bones, which may be easily separated from each other after the cartilages connecting them are destroyed. There are a few exceptions to this observation, for I have seen the middle portion of the sternum composed in the adult of three pieces, and the lowest piece split into two in a longitudinal direction. Frequently the two lower bones are found intimately united; and very often, in old people, the sternum is a continued bony substance from one end to the other; and with two, sometimes three, transverse lines on its surface; which are marks of the former divisions.

The sternum is broad and thick above, and becomes smaller as it descends. The internal surface of this bone is somewhat hollowed, for enlarging the thorax; but the convexity on the external surface is not so conspicuous, because the sides are pressed outwards by the true ribs; the cartilages of which are received into seven smooth pits, formed in each side of the sternum, and are kept firm there by strong ligaments, which, on the external surface, have a particular radiated texture †. The pits at the upper part of the sternum are at the greatest distance one from another, and, as they descend, are nearer; so that the two lowest are contiguous. This bone is covered by skin, and by the aponeuroses of the great pectoral and sterno-mastoid muscles.

The breast-bone is cellular, and covered by a very thin external plate, especially on its internal surface, where we may frequently observe a cartilaginous crust spread over it ‡. Hence it is rarely broken.

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* Στῆθος, Os Pectoris, ensiforme, scutum cordis.

† RUYSCH, Catalog. Rar. fig. 9.

‡ JAC. SYLV. in GALEN. de Ossibus, cap. 12.

The uppermost piece of the sternum is somewhat of the figure of a heart.

The upper middle part of this first bone, where it is thickest, is hollowed, to give place for the trachea; though this cavity * is principally formed by the bone being raised on each side of it, partly by the clavicles thrusting it inwards, and partly by the sterno-mastoidei muscles pulling it upwards.

On the outside of each tubercle, there is an oblong cavity, that, in viewing it transversely from before backwards, appears a little convex, which receives the ends of the clavicles. Immediately below these, the sides of this bone become thinner; and in each a superficial cavity or a rough surface is to be seen, where the first ribs are received or joined to the sternum.

On each side of the under end of this first bone, there is the half of the pit for the second rib.

The upper part of the surface behind is covered with a strong ligament, which secures the clavicles.

The second piece of this bone is much longer, narrower, and thinner than the first; a little narrower above than below, and is nearly equal in its dimensions.

There are pits for the third, fourth, fifth, and sixth ribs, and a half of the pits for the second and seventh, on the sides of this bone.

An unossified part is sometimes found near to the middle of this bone.

When the cartilage between this and the first bone is not ossified, a *manifest motion of this upon the first may be observed in respiration, or in raising the sternum*, by pulling the ribs upwards, or distending the lungs with air.

The third bone is much less than the other two, and has only one-half of the pit for the seventh rib formed in it; wherefore it might be reckoned only an appendix of the sternum. In young subjects it is always cartilaginous, and named, from its shape, *cartilago xiphoides*, *ensiformis*, or *mucronata*, being sometimes like a sword or shield, or bifid: and it is seldom of

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* Σφαγὴ Jugulum, Furcula.

the same figure, magnitude, or situation in any two subjects; for sometimes it is a plain triangular bone, with one of the angles below, and perpendicular to the middle of the upper side, by which it is connected to the second bone, but in others the point is turned to one side, or obliquely forwards or backwards.

In the greatest number of adults it is ossified, and tipped with a cartilage; in some one-half of it is cartilaginous, and in others it is all in a cartilaginous state. Several oblique ligaments are fixed at one end to the cartilages of the ribs, which connect the sternum firmly to those cartilages *.

When the lower end is ossified, and is too much turned outwards, it causes an ulceration of the superincumbent soft part, or if it is turned inwards, it deranges the functions of the stomach †.

The sternum is joined by cartilages to the seven upper ribs; and the unequal cavity on each side of its upper end is fitted for the ends of the clavicles.

The sternum of the fœtus is a mass of cartilage, upon which there are six or seven round pieces of bone; the uppermost of these is the largest.

In some full grown persons a small portion of the breast-bone is not ossified, leaving a cavity into which the point of the finger may be thrust.

This bone gives origin and insertion to several muscles; sustains the mediastinum, defends the heart and lungs, at the fore part; and, lastly, by serving as a moveable fulcrum of the ribs, assists considerably in respiration.

By the contraction of the intercostal muscles, the ribs must be pulled from the oblique position which their cartilages kept them in, nearer to right angles with the vertebræ and sternum, because the first or uppermost rib is the most fixed; and the cartilages making a great resistance to raising the an-

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* Weitbrecht, Syndesmolog. p. 121.

† Rolfing. Dissert. Anat. lib. 2. cap. 41. Paaw, de Ossib. part 1. cap. 3. & part 3. cap. 3. Codronchi de prolapsu Cartilagin. mucronat.

terior ends of the ribs, their large arched middle parts turn outwards as well as upwards.

The sternum, pressed strongly on both sides by the cartilages of the ribs, is pushed forwards, and that at its several parts, in proportion to the length and motion of its supporters, the ribs; that is, most at its lower end. The sternum and the cartilages thus raised forwards, must draw the diaphragm connected to them; consequently so far stretch it, and bring it nearer to a plane.

The power that raises this bone and the cartilages, fixes them sufficiently to make them resist the action of the diaphragm, the fibres of which contract at the same time, and thrust the viscera of the abdomen downwards. The arched part of the ribs being thus moved outwards, their anterior ends and the sternum being advanced forwards, and the diaphragm being brought nearer to a plane surface, instead of being greatly convex on each side within each cavity of the thorax, it is evident how considerably the cavity, of which the nine or ten upper ribs are the sides, must be widened, and made deeper and longer.

The cartilages of the inferior ribs having no fixed point to which their anterior ends are fastened, and the diaphragm being inserted into them at the place where it runs pretty straight upwards from its origin at the vertebra, these ribs are drawn downwards by this strong muscle, and by the muscles of the abdomen, which, at this time, are resisting the stretching force of the bowels; while the intercostal muscles are pulling them upwards: The effect, therefore, of either of these powers, which are antagonists to each other, is very little, as to moving the ribs either up or down; but the muscles of the abdomen, pushed at this time outwards by the viscera, carry these ribs along with them. Thus the thorax is not only shortened, but also widened at its lower part.

As soon as the action of these several muscles ceases, the reaction of the elastic cartilages draws the inferior ribs inwards at the same time. By these causes, the cavity of the breast is diminished in all its dimensions.

The movements of the ribs and breast-bone during respiration are only very obvious after violent exercise, or when the lungs are in a diseased state.

Where the ribs and their cartilages are distorted in rickety persons, the breast-bone is generally also deformed.

CHAP. IX.

OF THE SKULL.

THE bones of the SKULL have been divided into those of the *cranium*, and of the *face*.

The *craninm* *, helmet, or brain-case, consists of several pieces, which form a vaulted cavity, for lodging and defending the brain and cerebellum, with their membranes, vessels, and nerves.

The cranium is neither so broad nor so deep at its fore part, in which the anterior lobes of the brain are lodged, as it is behind, where the posterior lobes of the brain and cerebellum are contained.

The bones of the *face*, which constitute the under part of the skull, are irregular in form, and various in point of size, in different individuals, in the two sexes, and in different nations.

The bones of the skull correspond with the form and size of the parts included within them; hence the striking difference in their form in the human race, and in the inferior animals.

There is a most striking disproportion in the two great component parts of the skull in man, and in the inferior animals: in the former, the part of the skull appropriated to the lodge-

* Κογχος, κύτος, κωδεια, σκοφίον, calva, calvaria, cerebri galea, theca et olla capitis, testa capitis, scutella capitis.

ment of the brain, is full and large in proportion to the bones of the face, but the proportions are reversed in the inferior animals; for the bones of the face are very prominent, and often prolonged into a long snout, whilst those of the cranium, properly so called, are sunk as it were between the bones of the face. The line of the forehead of quadrupeds is very oblique: the forehead is narrow; the head is narrower above than at the orbits; and the eyes of the inferior animals are so placed that they see objects placed laterally, or even in some instances those that are behind them.

The greater expansion of the bones proper to the cranium, which indicates a large brain, has always been supposed to be characteristic of the superiority of the human intellect; and, on the other hand, large and extensive bones of the face indicate large and more perfect organs of smelling and tasting.

In short, the more the skull of an animal deviates as to volume from that of a man, the more ferocious and more stupid the animal.

That a large and prominent forehead is connected with superiority of intellect and beauty, is not a modern notion. The Greeks acted upon it in the construction of the busts of their gods and illustrious men, and even in many instances "overstepped the modesty of nature," conceiving that, by elevating the forehead, they gave superior dignity of character, and raised their gods or heroes beyond the level of ordinary men *.

It may be also remarked, that the forehead of the modern Greeks is much elevated. Dr Holland, whose long residence in Greece enabled him to judge accurately as to this point, has lately (January 1824) informed me by letter, that the form of the cranium somewhat tends towards the conical outline, but without losing the breadth of the frontal bones, which make a bold arch towards the apex of the head. To Sir Walter Scott I am much indebted, for the permission he gave me to examine a parietal bone and an os frontis which were sent to him, together with several other fragments of

* Vide Winkelmann, Hist. de l'art de l'Antiquité.

bones of the skull, by Lord Byron. These bones his Lordship found " in some ancient sepulchres within the long walls of Athens, in the month of February 1811 *."

The forehead of the individual to whom the os frontis had belonged, must have been nearly as high, and nearly as prominent, as that of the celebrated statue of the Venus de Medicis, but is narrower between the external angular processes than in the statue.

Dr Spurzheim observed to me, on looking at a cast of the statue of the Venus de Medicis, that the head was too small, and conveyed to his mind the representation of an ideot. But I am rather disposed to subscribe to the sentiments of a very distinguished friend, who remarked to me, If Gall and Spurzheim were both to swear themselves black in the face, I will never believe the Venus de Medicis to be any thing but an enchanting being, with as much sense as any one would desire a pretty woman to be possessed of. I argue the physiognomy in opposition to the supposed evidence of the skull.

There is a most striking difference in the position of the human head, and that of quadrupeds. The direction of the mouth, jaws, orbits and bones of the face, and position of the foramen magnum ossis occiptis, do not correspond; and even among the inhabitants of different parts of the globe, there is a difference as to the placing of the great occipital foramen,—a circumstance which led Daubenton to take the position of the foramen magnum of the occipital bone as an index to the distinctions between the form of the skulls of the different nations of the globe, and also between the form of the human skull and that of the inferior animals, for which latter purpose it is much better calculated than for the former.

The head is fixed in such a manner to the atlas, and second vertebra of the neck, as combines considerable firmness and latitude of motion.

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* Copied from an inscription upon one side of a very elegant silver vase, which was presented by Lord Byron, together with the bones, to Sir Walter Scott.

The human head is not equipoised on the atlas: it is somewhat heavier before than behind, and therefore the chin drops down on the breast, when a person falls asleep, and when the extensor muscles of the head do not act.

In most quadrupeds, the foramen magnum ossis occipitis is placed much farther back than in the human skull; the jaws are much elongated, the hind head scarcely projects beyond the spine; hence quadrupeds can readily seize their prey when it is before them, above or beneath them, by a trifling movement of the head.

The skull, generally speaking, may be said to be of an oval form, somewhat broader behind than before, and flattened at the sides; but there are many deviations from this form, which may be noticed by a careful examination, even amongst the skulls of persons of the same nation, the same age, and the same sex. A still greater diversity of form is to be observed amongst the inhabitants of different parts of the globe.

The distinctions between the skulls of different nations did not escape the observation of HIPPOCRATES.

They are also mentioned and commented upon by HERODOTUS, ARISTOTLE and PLINY.

In more modern times, much attention has been devoted to this very curious subject, by VESALIUS, HALLER, BUFFON, CAMPER, BLUMENBACH, and other authors. This subject is well worthy of prosecution, as tending to bring to light many curious circumstances with regard to the history of mankind, by supplying data which may lead to the detection of the origin of particular nations.

Much caution is requisite in the prosecution of this inquiry, for there are many sources of deception.

In the *first* place, In consequence of the great intercourse which commerce has established betwixt the various quarters of the world, and frequent intermarriage, the features peculiar to certain nations are gradually effaced, so as at length not to be discernible; skulls, therefore, possessing the genuine original characters of a nation are not to be found.

2d, The distinctive characters of nations are frequently im-

perfectly marked, and the peculiarities of one nation slide as it were imperceptibly into those of another.

To form a classification of the different races of men, free from all objections, would require a great number of specimens, and a knowledge of the customs of nations; for some nations, by pressure artificially applied in early life, materially alter the natural conformation of the skull: disease also materially alters the form of the cranium.

The rickets, diseases of the sinuses of the head, and lues venerea, bring about a most remarkable change in the natural form of the head. I shall never forget the change produced on the profile of a boy of 10 years of age, by the sinking of his nose, which rendered his profile like that of an African Negro. Upon dissection, the portion of the nose and palate bones were found almost destroyed, as also the uvula and velum palati. It merits notice, that there was no distinct evidence of the boy having been contaminated by the venereal poison.

Of the Surfaces of the Skull.

The outer surface of the upper part of the skull is very smooth and equal, being covered only by the thin serous membrane, the *pericranium*, the thin frontal and occipital muscles, their tendinous aponeuroses, cellular substance, a few small bloodvessels, nerves, and the skin; but on the outer surface of the base of the skull there are many risings, depressions and foramina, for the origin of the numerous muscles connected with it, and for the bloodvessels and nerves that pass through and near to it. The inner surface of the upper part corresponds exactly with the surface of the dura mater; there are a number of furrows disposed somewhat like to the branches of a tree, in which the branches of the arteries of the dura mater are lodged, and there are also pits of different sizes and forms, which correspond to corresponding eminences on the surfaces of the brain and dura mater. Over these pits, the skull is much thinner than any where else, and often rendered diaphanous, the two tables being closely ap-

plied to each other; and vessels go from the dura mater into a great many small holes observable in the pits.

These vessels arelarger than the others that pass from the dura mater to the skull; as evidently appears from the discharge of blood in the recent subject, when the skull is raised from the dura mater. Over these pits the skull is remarkably thin; therefore, surgeons ought to saw cautiously and slowly through the external table of the skull, when they are performing the operation of the trepan; as the dura mater and brain may be injured before the instrument has pierced a skull of the ordinary thickness.

The inner surface of the skull is very uneven, being deeply imprinted by the contained parts; and besides, there are many eminences for the bloodvessels and nerves connected with the brain and smaller brain.

The bones of the cranium are composed of two tables, which are not parallel to each other, and of intermediate *cancelli*, commonly called their *diploë*. The external table is rather thicker than the inner, which, on account of its thinness and brittleness, has been called *vitrea*.

The diploë is similar in texture, and of equal utility, to the skull, as the cancelli in other bones. Some animals, especially the elephant, have this of very considerable thickness. The arteries and veins of the diploë are numerous, and freely anastomose with each other, especially the veins; and they acquire in old persons a more considerable size than in middle age.

The diploë in some persons of middle age, and generally in the old, is obliterated; neither is it observable in some of the hard bones at the base of the skull. The diploë sometimes attains the thickness of an inch, while the tables of the skull are not of an extraordinary size. *Vide* Plate XII. in my Outlines of Anatomy, which was copied from the skull of a rickety person. In some instances the principal artery of the dura mater is lodged between the tables of the skull.

The above circumstances suggest the necessity of proceeding with caution in performing the operation of trephining,

and also the impossiblity of distinguishing when the external table of the skull only has been divided by the trepan.

The cranium of the adult consists of eight bones; only six of which are said to be proper, and the other two are common to it and the face. The six proper, are the *os frontis*, two *ossa parietalia*, two *ossa temporum*, and the *os occipitis*. The common are the *os ethmoides* and *os sphenoides*. The *os frontis* might also be enumerated as being common to the cranium and bones of the face.

The os frontis forms the whole fore part of the vault; the two ossa parietalia form the upper and middle part of it; the ossa temporum compose the lower part of the sides; the os occipitis makes the whole hinder part, and a part of the base; the os ethmoides is placed in the fore part of the base, and the os sphenoides is placed across the middle of it.

These bones are joined to each other by five *sutures;* viz. the *coronal*, *lambdoid*, *sagittal*, and two *squamous*.

The *coronal* suture * extends over the head, from within an inch or so of the external canthus of one eye, to the like distance from the other. The indentations of this suture are conspicuous in its upper part, but it is squamous and smooth for an inch or more on each side towards its extremity.

The *lambdoidal* suture begins some way below, and further back, than the vertex or crown of the head, whence its two legs are stretched obliquely downwards on each side, in form of the Greek Δ, and extend to the base of the skull.

This suture is sometimes diverted from its usual course by small and irregularly shaped bones, called *Ossa Triquetra*, which are generally larger and more conspicuous on the external surface of the skull than internally. In the chronic form of hydrocephalus, a great number of ossa triquetra are formed, (*Vide* Plate XXI. in my Outlines of Anatomy), in order that the softer parts may be better protected; and before these small bones are consolidated to the rest of the skull, they yield

* So named in consequence of being placed where the ancients applied their coronæ.

inwards when pressed upon, which circumstance has led some parents to suppose the skull had been fractured.

Ossa triquetra are sometimes seen in the other sutures, and sometimes in one table of the skull, but not in the other *.

The *sagittal* suture is situate in the middle of the upper part of the skull, between the coronal and lambdoid sutures; between which it is said to be placed, as an arrow is between the string and bow: frequently it is continued through the middle of the os frontis, down to the root of the nose; which, according to some †, oftener happens in women than in men.

In old persons, the sutures are generally imperceptible; and sometimes even in the meridian of life. The sutures are sometimes double. I have also seen two squamous sutures on each side of the head; and in the skull of an Esquimaux the lambdoidal suture was double.

The *squamous* or *false sutures*, are one on each side, a little above the ear, of a semicircular figure, formed by the overlapping (like one scale upon another) of the upper part of the temporal bones on the lower part of the parietal, where, in both bones, there are a great many small risings and furrows, which are indented into each other; though these inequalities do not appear till the bones are separated. In some skulls, indeed, the indentations are as conspicuous externally as in other sutures ‡: and what is commonly called the posterior part of this squamous suture, always has the evident serrated form; and therefore is reckoned by some ‖ a distinct suture, under the name of *additamentum posterius suturæ squamosæ*. I have seen two squamous sutures on the same temple, with a semicircular piece of bone between them §.

The true squamous sort of suture joins all the edges of the bones on which each temporal muscle is placed: for the two parts of the sphenoidal suture which are continued from the

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* Hunauld. in Mem. de l'Acad. des Sciences, 1730.

† Riolan. Comment. de Ossib. cap. 8.

‡ Columb. de Re Anat. lib. 1. cap. 4. Dionis, Anat. 3, Demons. de Oss.

‖ Albin. de Ossib. Sect. 54.

§ Sue, Traité. d'Osteolog. p. 48.

anterior end of the common squamous suture just now described, of which one runs perpendicularly downwards, and the other horizontally forwards, and also the lower part of the coronal suture already taken notice of, may be said to be parts of the squamous suture. The thin edges of bones, when accurately applied one to another, present a smooth surface; and, therefore, the superincumbent temporal muscle is not injured during its action; which is still further provided for by the manner of laying these edges on each other; for, in viewing their outside, we see the temporal bones covering the sphenoidal and parietal, and this last supporting the sphenoidal, while both mount on the frontal: From which disposition, it is evident that these bones mutually support each other.

The bones of the skull are joined to those of the face, by *schyndelesis* and *sutures*. The schyndelesis is in the partition of the nose. The sutures said to be common to the cranium and face are, viz. the *ethmoidal*, *sphenoidal*, *transverse*, and two *zygomatic*.

The *ethmoidal* and *sphenoidal* sutures surround the bones of these names; and in some places form part of other sutures, particularly the squamous and transverse.

The *transverse* suture stretches across the face from the external canthus of one orbit to that of the other, by sinking from the canthus down the outside of the orbit to its bottom; then mounting upon its inside, it is continued by the root of the nose down the internal part of the other orbit, and rises up again on its outside to the other canthus. There are, however, some interruptions of this suture in the above course; for the bones are not contiguous every where.

The *zygomatic* sutures, situate between the temporal and cheek bones, are short, and slanting from above obliquely downwards and backwards; and the indentations of the sutures are not so distinct on the inside of the cranium as on the outside; for, in some skulls, the sutures are observable only externally, which may possibly be owing to the less extent of the concave than of the convex surface of the cranium.

In consequence of the interposition of the sutures of the cranium,

1. The bones which are at some distance from each other at birth yield, whereby the shape of the head is accommodated to the form of the pelvis of the mother. Whence, in childbed, the bones of the cranium, during difficult labour, overlap each other.

2. The skull is more easily formed and extended into a spherical figure.

3. There is a free communication of the vessels without, and of those within the skull, larger here than in any other part of the cranium; and therefore fomentations, cataplasms, blisters, and issues, are applied most efficaciously for the relief of diseases of the brain.

4. The dura mater is more firmly fixed to the skull at this conjunction of the bones, with the greatest benefit.

5. By a suture, the course of a fracture, that is nearly spent, is sometimes arrested.

6. According to the late Mr Gibson of Manchester, the bones of the skull extend chiefly at the edges; the sutures admit of the intervention of a vascular membrane, which secretes the bony substance, and when ossification has been completed, the sutures are obliterated.

Life is prolonged by a separation of the bones of the skull: thus the acute is converted into the chronic form of hydrocephalus.

Os Frontis.

The os frontis forms a large share of the *forehead.* It is generally symmetrical, and has some resemblance in shape to the shell of the concha bivalvis commonly called the *cockle;* for the greatest part of it is convex and smooth externally, and concave internally, with a serrated circular edge; while the smaller part has processes and depressions, which make it of an irregular figure.

This bone forms the upper and arched part of the socket for the eye-balls, called Superciliary Ridges, which are bounded outwardly by the external, and internally, or next to the nose, by the internal angular processes.

Mr CHANTREY, the celebrated sculptor, pointed out to me, in the profile of the Apollo Belvedere, the great length of the superciliary ridge, which is, in that celebrated statue, much greater than ever it is in nature. Hence the orbit must be very large; and indeed it was the object of the sculptor to make the orbit large, a large eye being reckoned, by the ancient sculptors, very beautiful. It would appear that there is no part of the face in which there was so much of the ideal in ancient sculpture as in the orbit.

Very little above the internal end of each of the superciliary ridges, a protuberance may be remarked, in most skulls, where there are large cavities, called *sinuses*, within the bone. Betwixt the internal angular processes, there is a small process which forms a part of the nose, and thence is named *nasal*.

Some observe a protuberant part on the edge of the bone behind each external angular process, which they call *temporal* processes.

From the under part of the superciliary ridges, the frontal bone runs a great way backwards, to form its *orbitar* processes. These are concave externally, for receiving the eye-balls, with their muscles, fat *, &c.

Behind the superciliary ridges, and towards the external angular processes, a considerable sinuosity is observed, where the *glandula innominata Galeni* or *lachrymalis* is lodged.

Behind each internal angular process, a small pit may be remarked, for the attachment of the cartilaginous pully of the *musculus obliquus major* of the eye.

There is a vacant space betwixt the two orbitar processes, into which the cribriform part of the *os ethmoides* is inserted. The frontal bone frequently has little caverns formed in it here, where it is joined to the ethmoid bone.

Behind each external angular process, the surface of the frontal bone is considerably depressed, where part of the *temporal* muscle is placed.

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* For a particular account of the orbits, see CAMPER, Diss. Phys. de quibusdam oculi partibus; and the 7th chap. of ZINN, Descrip. anat. oculi humani.

There are three *foramina* or *holes* on each side, on the external surface of the frontal bone. There is one in each superciliary ridge, a little removed from its middle towards the nose; through which a twig of the *ophthalmic* branch of the fifth pair of nerves passes out of the orbit, with a small branch from the internal carotid artery, which is distributed on the teguments and muscles of the forehead.

Instead of holes in the superciliary ridges, there are sometimes only notches; and, in some skulls, not even a notch; and sometimes there is a notch on the one side, and a hole in the other.

The vessels, in some skulls, make furrows in the os frontis, especially in the bones of children, as has also been observed of another considerable vessel of this bone, near its middle *; and hence the danger of transverse incisions on either side of the os frontis, which might either open these vessels or hurt the nerves, while they are yet in part within the bone; for, when vessels are thus wounded, it is difficult to stop the hæmorrhagy, because the adhesion of a part of the artery to the bone hinders its contraction.

Near the middle of the inside of each orbit, hard by, or in the transverse suture, there is a small hole called *Foramen Orbitarum* or *Internum*, for the passage of the nasal twig of the first branch of the fifth pair of nerves, and of a branch of the ophthalmic artery. The hole is sometimes entirely formed in the os frontis; in other skulls, the sides of it are composed of this last bone, and of the os planum. There is another and smaller hole, called *Orbitarium Internum Posterius*, about an inch deeper in the orbit; through which a small branch of the ocular artery passes into the nose.

There are also a great number of small holes observable on the outer surface of this bone, particularly in the two protuberances above the eye-brows. Most of these penetrate no farther than the sinuses, or than the diploë; though sometimes I have seen this bone so perforated by a vast number of these small holes, that, placed between the eye and a clear light, it appeared like a sieve.

* Ruysch, Mus. Anat. Theca. D. Reposit. 4. No. 3.

In most skeletons, we may observe one, two, or more holes, sufficient to allow the passage of a hog's bristle through the skull. The place, size, and number of these, are however uncertain: they generally serve for the transmission of small arteries or nerves.

The internal surface of the os frontis, is, generally speaking, concave; but very irregular, in consequence of the convolutions of the brain, except at the orbitar processes, which are convex, to support the anterior lobes of the brain. This surface is not so smooth as the external; for the larger branches of the arteries of the dura mater imprint the lateral and posterior part of this bone. The internal surface of the bone is divided by a ridge, to which the upper edge of the falx is fixed, and this ridge is expanded into a groove, in which the anterior part of the superior longitudinal sinus is lodged. Hence the risk of the application of the trepan to this part of the skull. Immediately at the root of this ridge or furrow, there is a small hole, which sometimes pierces through the first table, and, in other skulls, opens into the superior sinus of the ethmoid bone within the nose. In it, a little process of the falx, a small artery, and sometimes a vein are lodged; and the superior longitudinal sinus begins here. This hole, however, is often not entirely proper to the os frontis; for, in several skulls, the lower part of it is formed in the upper part of the base of the crista galli, a process of the ethmoid bone *.

The os frontis is composed of two tables, and an intermediate diploë, and is of a middle degree of thickness between the os occipitis and the parietal bones; is pretty equally dense, excepting at the orbitar processes, where, by the action of the eye on one side, and pressure of the lobes of the brain on the other, it is made extremely thin. Hence the fatal effects of a blow or thrust with a sword in the eye. Wepfer informs us they killed oxen at Rome, by running a knife into the orbits. Morgagni † has also made mention of the fatal consequences of blows on this part of the frontal bone.

* Ingrass. Comment. in Galen. de Ossib. cap. 1. comment. 8.

† Epist. 51. Art. 58.

The two tables of the frontal bone are disunited at the fore and under part of that bone, and the intervening space or spaces have been called the Frontal Sinuses.

The situation of these frontal sinuses is much more marked in some than in other skulls, and generally it is more apparent in the forehead of the male; and, according to common observation, the size of the frontal sinuses bears a ratio to the age of the individual,—a position which is however not confirmed by the skulls in my possession, as the frontal sinuses are equally capacious in several skulls containing all the teeth, as in others where the teeth and alveolar processes are totally awanting.

In some European skulls in my museum, the risings in the frontal bone over the frontal sinuses, bear a very exact resemblance to a couple of chemical retorts, the larger or bulbous parts of which are distant from each other about an eighth of an inch, and with their smaller extremities directed outwards, and in contrary directions: but, in a few instances, there is no intervening flat space externally between the sinuses.

There is also the utmost variety as to the size of the frontal sinuses in different nations.

In the Negro and Carib skulls, they are small and flat; but, on the other hand, they are remarkably large in the skull of a Frenchman, who was only twenty-three years of age; in three skulls of natives of New South Wales; in two skulls that were brought from Van Dieman's Land, and in a skull found in the Catacombs at Paris.

The frontal sinuses are also very conspicuous in the skull of a Norwegian in my possession, owing to the sudden manner in which the frontal bone immediately over the sinuses inclines backwards. But it is not always possible to judge of the extent of the sinuses, by an examination of the outer surface of the skull; for in some specimens, I found the depth to be much greater than in others, so that when the sinus was opened, it extended across the upper part of the orbit, and on each side of the ethmoid bone, and reached as far back as the sphenoid bone.

There is no elevation of the fore part of the frontal bone in the skull of a child at birth; and according to SOEMMERING, "primis vitæ annis exigua sunt amplitudine, et peractis demum pubertatis annis, ratam amplitudinem nanciscuntur; vel duodecimo vitæ anno, non nisi vestigium eorum in inferiore ossis parte conspicitur, eo enim loco, quem posthac occupant, tunc temporis nil est, nisi diploë *."

Upon opening these sinuses, the different form of the inner and outer table of the skull is conspicuous: the former is very irregular, and evidently moulded upon the convolutions of the brain; but not the outer table. The two tables of the bone are not parallel to each other, a circumstance which has been long familiar to surgeons, and which renders it difficult to apply the trephine to this part of the skull.

The above circumstance also demonstrates the impossibility of arriving at a precise knowledge of the exact form of this part of the brain of the adult, by an external examination of the head.

The sinuses are generally equal as to size and form, and are separated by a middle partition; sometimes they communicate with each other; and, in some skulls, there are smaller partitions in each sinus, which consists of a number of cells of different forms and sizes.

In the museum, there are 45 skulls of adults, cut with a view to exhibit the different sizes and forms of the frontal sinuses; and in three of these there was no appearance of frontal sinuses. The occasional total absence of frontal sinuses has escaped the observation of PALFIN †, BERTIN ‡, PORTAL ||, SOEMMERING §, CALDANI ¶, and other anatomists.

It merits mention, that two of these were skulls of persons

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* De Corpor. human. fabr. vol. 1. p. 96.

† Anat. Chirurg. du PALFIN, par PETIT, p. 52.

‡ Traité d'osteologie, tom. .ii. p. 10.

|| Cours d'Anat. Medic. tom. i. p. 102.

§ De Corp. human. fab. vol. i. p. 94.

¶ Instit. Anat. Venetiæ, 1791. vol. i.

very far advanced in life, and that the skulls were as thick as if the frontal sinuses had been present, for the space between the tables of the frontal bone was filled up by a cancellated bony structure.

I measured the breadth, or distance across the forehead; the height, or distance from the transverse suture upwards, where it divides the frontal bone and bones of the nose, and also the depth of the frontal sinuses, in nine different skulls in which these sinuses were large, and found them as under:

No.	Breadth.	Height.	Depth.
1	3 inches.	$1\frac{5}{8}$	$1\frac{5}{8}$
2	$2\frac{7}{8}$		$1\frac{7}{8}$
3	$3\frac{7}{8}$		$\frac{7}{8}$
4	$3\frac{2}{8}$		$1\frac{5}{8}$
5	$2\frac{2}{8}$		$\frac{1}{2}$
6	3	$1\frac{3}{8}$	$1\frac{1}{2}$
7	$2\frac{7}{8}$		$\frac{5}{8}$
8	$2\frac{6}{8}$	$1\frac{1}{2}$	$\frac{7}{8}$
9	3		$2\frac{1}{8}$ *

The frontal sinuses communicate with the ethmoidal sinuses by a rounded aperture at the inner and lower parts of the internal angular processes, and at the upper and posterior portions of the os unguis. These passages of communication are by no means uniform in point of size, and in some of the skulls were twice as large as in others.

The sinuses may be compared to vaults: they increase the intensity of the sound of the voice, and also render it more melodious.

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* In this specimen the frontal sinuses extended backwards to the sphenoid bone.

In some cases, the sinuses attain a very unnatural size, when polypi or other tumours are lodged within them. Notwithstanding the danger which has been supposed to arise from a fracture of the frontal bone over these sinuses, I have seen instances, in which a very large portion of the frontal sinuses had been detached by a fracture, and was removed: yet the patient obtained a complete recovery. Owing to the sensibility of the mucous lining of the sinuses, inflammation, or worms lodged in these sinuses, create great uneasiness.

The upper circular part of the os frontis is joined to the ossa parietalia, from one temple to the other, by the coronal suture. From the termination of the coronal suture to the external angular processes, this bone is connected to the sphenoid by the sphenoidal suture. At the external canthi of the eyes, its angular processes are joined by the transverse suture to the ossa malarum, to which it adheres one-third down the outside of the orbits; whence to the bottom of these cavities, and a little up on their internal sides, these orbitar processes are connected to the sphenoidal bone by the same suture. In a few skulls, however, a discontinuation of these two bones appears at the upper part of the long slit, near the bottom of the orbit. On the inside of each orbit, the orbitar process is indented between the cribriform part of the ethmoid bone, and the os planum and unguis. The transverse suture afterwards joins the frontal bone to the superior nasal processes of the ossa maxillaria superiora, and to the nasal bones. And, lastly, its nasal process is connected to the nasal lamella of the ethmoid bone.

The frontal bone serves to defend and support the anterior lobes of the brain. It forms a considerable part of the cavities that contain the eye-balls, and also a part of the septum narium, organ of smelling, &c.

The frontal bone of the fœtus consists of two parts; one of which is sometimes more prominent than the other, when water has been accumulated within the brain. The superciliary holes are not formed; often a small round piece of each orbitar process, behind the superciliary ridge, is not ossified, and there is no sinus to be seen within its substance.

In some monsters, a great portion of the upper part of the frontal bone is awanting, and also a part of the parietal bones.

Ossa Parietalia.

The OSSA PARIETALIA, or bones serving as walls to the encephalon, are of an irregular square form; their upper and fore side being longer than the one behind or below. The inferior side is a concave arch; the middle part receiving the upper round part of the temporal bone. The angle formed by this upper side, and the fore one, is so extended, as to have the appearance of a process.

The external surface of each os parietale is convex. Upon it, somewhat below the middle height of the bone, there is a transverse arched ridge, of a whiter colour generally than any other part of the bone; from which a great many converging furrows, like so many *radii* drawn from a circumference towards a centre, occasioned by the pressure of the fibres of the temporal muscle, are very obvious, more particularly in the skull of a Negro now mentioned. Below these, we observe, near the semicircular edges, a great many risings and depressions, which are joined to like inequalities on the inside of the temporal bone, to form the squamous suture. The temporal bone may therefore serve as a buttress, to prevent the lower side of the parietal from starting outwards when its upper part is pressed or struck *.

Near to the sagittal suture, there is commonly a small hole, through which a vein passes from teguments of the head to the longitudinal sinus. Sometimes I have seen a branch of the temporal artery pass through this hole, which was distributed on the upper part of the falx, and the dura mater, which frequently joins with the branches of the arteries of the dura mater. In several skulls, one of the ossa parietalia has not this hole; in others, there are two in one bone; and in some, not one in either. Most frequently this hole is through both tables; at other times, the external table only is perforated. The knowledge of the course of these vessels, may be

* HUNAULD in Mém. de l'Acad. des Sciences, 1730.

of use to surgeons, when they make any incision near this part of the head; lest, if the vessels are rashly cut near the hole, they shrink within the substance of the bone, and occasion an obstinate hæmorrhagy, which cannot be stopped.

My grandfather, in his manuscript commentary upon his Osteology, has observed on this hole:—"Whether it is an artery or a vein that passes through this hole, an obstinate hæmorrhage may be caused by cutting it very near to the hole, for if it is a vein it communicates with the superior longitudinal sinus, which may furnish blood as long as the orifice, shrunk within the substance of the bone, is open; and if it is an artery, it communicates both with the largest lateral artery of the dura mater, and with the internal carotid, from the anastomosing canals of which the blood may flow into this one, to have a motion retrograde to what it has naturally, and to occasion likewise an hæmorrhage, that neither stitching nor pressure can be applied to stop, and where escharotics or styptics cannot have their full effect. I remember to have seen a man, who in his drunkenness fell down a stair, and cut this part of his head, which bled so obstinately, that four or five of our best surgeons could not stop it any considerable time, till the man became so faint, that he lay with little sense or motion for several days; after this there was no more bleeding, and he recovered. I saw this man a few years ago, he shewed me the scar of his wound, which is at a place in the head where there is not any other vessel but what might have been easily stopped from bleeding. Styptics with pressure continued long on the part, are what I would try in such a case. If this had not success, I would push the point of a red hot iron into the hole: you may believe that I would have the iron of a conical figure; so that it should not pass through the skull to hurt the internal parts, and that I would not keep it long applied, lest the dura mater should be injured."

On the inner concave surface of the parietal bones, there are a great many deep furrows, for lodging the arteries distributed on the surface of the dura mater and the large venous sinuses. The furrows for the arteries are disposed

somewhat like the branches of trees; and are largest and deepest at the lower edge of each os parietale, especially near its anterior angle, where sometimes a complete canal is formed: They afterwards divide into small furrows, in their progress upwards. There are three instances in the museum, in which a large trunk of the principal artery of the dura mater is covered only by the outer table of the skull. In some skulls, a large furrow begins at the hole near the upper edge, and divides into branches, which join with those which come upwards; thus the upper and lower vessels of the dura mater, communicate with each other. In these furrows we frequently see passages in the diploe; and sometimes I have observed canals going off, which allowed a small probe to pass some inches into the bony substance. Some * authors have observed these canals piercing the bone towards the occiput. The conjoined ossa parietalia, form a canal which is frequently larger in the bone of one side than of the other, where the upper part of the falx is fastened, and the superior longitudinal sinus is lodged. A part of the lateral sinuses makes a depression near the angle formed by the lower and posterior sides of these bones.

These bones are joined in front to the os frontis by the coronal suture; at their long inferior angles, to the sphenoidal bone, by part of the suture of this name; at their lower edge, to the ossa temporum, by the squamous suture and its posterior additamentum; behind, to the os occipitis, or ossa triquetra, by the lambdoid suture; and above, to one another, by the sagittal suture.

In a child born at the full time, none of the sides of this bone are completed.

These bones are more frequently broken than any other of the bones of the skull, especially towards their juncture with the temporal bones, and the fracture generally extends upwards, but sometimes it passes downwards, and stretches across the base of the skull.

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* Cowper, Anatom. Explic. of XC. Tab. Fig. 1.

There is a want of bone in the upper and fore part of the head of a child at the period of birth, owing to the imperfect ossification of the parietal and frontal bones. This unossified portion has been called *bregma*, or *fons pulsatilis*, on account of the pulsation of the brain felt through this flexible ligamento-cartilaginous substance.

By an accurate examination it may be ascertained whether the fœtus in utero be alive or not. The surgeon may apply his finger to the bregma when the os uteri is a little opened. If the bregma is stretched, and the pulsation of the brain is felt through it, the child is certainly alive: But if it is shrivelled and flaccid, without any observable pulsation in it, there is some reason to suspect the child to be very weak, or dead.

The ossification of the bregma is generally perfect before five years of age.

Ossa Temporum.

The Ossa Temporum are equal and smooth above, with a very thin semicircular and ragged edge. Behind this, the upper part of the temporal bone is thicker, and more unequal, and is sometimes described as a distinct part, under the name of *pars mammillaris* *, or mastoidea.

Towards the base of the skull, the temporal bone appears very irregular and unequal; and from it an oblong very hard substance, called Pars Petrosa, is extended horizontally forwards and inwards, which in its progress become smaller.

The external processes of each temporal bone are, 1*st*, The mastoid, which is placed at the lower and hind part of the bone, the surface of which is scabrous, for the insertion of the sterno-mastoid, the trachelo-mastoid and splenius muscles. It is not solid, but within is composed of cancelli, or small cells, which have a communication with the cavity of the ear called Tympanum. About an inch farther forward, the second process takes its rise; and having its origin continued obliquely downwards and forwards for some way, it becomes

* Albin. de Ossib. § 26.

smaller, and is stretched forwards to join with the *os malæ;* they together forming the bony *jugum*, under which the temporal muscle passes. Hence this process has been named *zygomatic.* To the upper edge the strong aponeurosis of the temporal muscle is fixed; and its lower part gives rise to a share of the *masseter.* The fore part of the base of this process is oblong; and in a recent subject is covered with a smooth cartilage, continued from that which lines the cavity immediately behind this tubercle.

From the under craggy part of the *os temporum*, the third process stands out obliquely forwards, which in shape resembles the ancient *stylus scriptorius;* and therefore it is called the *styloid* process. The muscles called *stylo-glossus*, *stylo-hyoideus*, *stylo-pharyngeus*, take their rise from this process, and a ligament of the os hyoides is sometimes fixed to it, and another is extended from it to the inside of the angle of the lower jaw.

This process is often, even in adults, ligamentous at its root, and sometimes is composed of two or three distinct bones. Around the root of it, especially at the fore part, there is a remarkable rising of the os petrosum, which some have esteemed a process; and, from the appearance it makes with the styliform, have named it *vaginalis.* Others, again, have, under the name of *auditory* process, reckoned among the external processes that semicircular ridge, which, running between the root of the mastoid and zygomatic processes, forms the under part of the external *meatus auditorius.*

It sometimes, though very rarely, happens that there is a small and rounded bone extending between this process and the os hyoides.

The sinuosities or depressions on the external surface of each os temporum are: A long fossa at the inner and back-part of the root of the mastoid process, where the posterior head of the digastric muscle has its origin. Immediately before the root of the zygomatic process, a considerable hollow is left, for lodging the temporal muscle.

Between the zygomatic, auditory and vaginal processes there is a large cavity; through the middle of which, from

top to bottom, a fissure is observable, into which part of the ligament that secures the articulation of the lower jaw with this bone is fixed.

The fore part of the cavity being lined with the same cartilage which covers the tubercle before it, receives the condyle of the jaw; and in the back part, a small share of the parotid gland and fat is lodged.

At the inside of the root of the styloid apophyse, there is a thimble-like cavity, where the beginning of the internal jugular vein, or end of the lateral sinus, is lodged. As the sinuses of the two sides are frequently of unequal size, one of these cavities is as often larger than the other *. Around the external meatus auditorius, there are several small holes for the more firm adhesion of the external cartilage of the ear.

There are several holes on the outside of each of these bones.

The *first* is the orifice of a large funnel-like canal, which leads to the organ of hearing; therefore called *meatus auditorius externus;* the form and size of which are very various in different individuals; it is placed between the zygomatic and mastoid processes.

The *second* gives passage to the *portio dura* of the seventh pair of nerves, and, from its situation between the mastoid and styloid processes, is called *foramen stylo-mastoideum.*

Some way before, and to the inside of the styloid process, there is a canal for the internal carotid artery and the beginning of the intercostal nerve. It passes upwards and forwards. Where this canal is about to make the turn forwards, one, or sometimes two, very small holes go off towards the *tympanum;* in these VALSALVA † affirms, the proper artery, or arteries, of that cavity are lodged.

The orifice of the Eustachian tube, which runs outwards and backwards, in a horizontal direction, to the tympanum, may be observed on the anterior surface of this bone.

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* HUNAULD, in Mém. de l'Acad. des Sciences, 1730.

† De Aure humana, cap. 2, § 22. et tab. 7. fig. 1.

On the external side of the bony part of this canal, and at the top of the chink in the cavity that receives the condyle of the lower jaw, the small nerve which is reflected from the lingual branch of the fifth pair, is situated.

Another hole is common to the temporal and occipital bones; it gives passage to a vein from the external teguments to the lateral sinus: But, in some subjects, a branch of the occipital artery passes through this hole, which is spent on the back part of the dura mater; in others, I have seen two or three such holes: But they are oftener wanting than found.

The internal surface of the ossa temporum is unequal; the upper circular edge of the squamous part having numerous small ridges and furrows for its conjunction with the parietal bones; and the rest of it being irregularly marked by the convolutions of the middle part of the brain, and by furrows made by the branches of the arteries of the dura mater.

From the under part of this internal surface, a large transverse hard craggy protuberance, the *pars petrosa*, runs horizontally inwards and forwards, with a sharp edge above, and two flat sides, one facing obliquely forwards and outwards, and the other as much backwards and inwards. To the ridge between these two sides, the large lateral process of the dura mater is fixed.

Notwithstanding the great hardness of this part of the temporal bone, it has sometimes been broken in consequence of a fall on the head, and such injuries very often prove fatal; the fracture extends across the base of the skull. This fracture may sometimes be distinguished by the extreme urgency of the symptoms, and the considerable discharge of blood from the ears.

Sometimes a small sesamoid bone is found between the narrow extremity of this petrous process, and the sphenoid bone *.

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* Riolan, Comment. de Ossib. cap. 32. Winslow, Exposition Anatomique de corps humain, trait des os secs, sect. 266.

Towards the back part of the inside of the os temporum there is a large deep fossa for the lateral sinus; and frequently on the top of the petrous ridge, a furrow may be observed, where a small sinus is situated.

The internal foramina proper to each of these bones are, *first*, the internal *meatus auditorius* in the posterior plain side of the petrous process. This hole soon divides into two; one of which is the beginning of the *aqueduct* of FALLOPIUS; the other ends in several very small canals *, that allow a passage to the branches of the *portio mollis* of the seventh pair of nerves, into the *vestibule* and *cochlea*. Through it also an artery is sent, to be distributed to the organ of hearing. The *second* hole, which is on the anterior plain side of the craggy process, gives passage to a reflected branch of the second branch of the fifth pair of nerves, which joins the portio dura of the auditory nerve, while it is in the aqueduct †, small branches of bloodvessels accompanying the nerves, or passing through smaller holes near this one. The passage of the cutaneous vein into the lateral sinus, or of a branch of the occipital artery, is seen about the middle of the large fossa for that sinus; and the orifice of the canal of the carotid artery is evident at the under part of the point of the petrous process.

Besides these proper holes on the external and internal surfaces of the temporal bones, there are two others in each side that are common to this bone and to the occipital and sphenoidal bones.

The temporal bones are joined above to the parietal bones by the squamous sutures, and their posterior additamenta: Before, to the sphenoid bone at the suture of that name; to the cheek-bones at the zygomatic sutures: Behind, to the occipital bone, at the lambdoid suture and its additamenta; and they are articulated with the lower jaw, in the manner which shall be described when this bone is examined.

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* Dr MONRO 2d on the Nervous System, tab. xxiv.

† Dr MONRO 2d on the Ear.

In an infant, a small fissure is to be observed between the thin upper part, and the lower craggy part of each of these bones; which points out the recent union of these parts. The mastoid and styloid processes are awanting. Instead of a bony funnel-like external meatus auditorius, there is only a smooth bony ring, within which the membrane of the drum is fastened. At the entry of the Eustachian tube, the side of the tympanum is not completed. A little more outwardly than the internal auditory canal, there is a deep pit, over the upper part of whose orifice the interior semicircular canal of the ear is stretched; and some way below this, the posterior semicircular canal also appears.

There is a specimen in the museum, in which there is no appearance of either of the meatus auditorii.

Os Occipitis.

The Os Occipitis, so called from its situation, is convex externally, and concave internally. Its figure is an irregular square, or rather rhomboid; of which the angle above is generally a little rounded; the two lateral angles are more finished, but obtuse; and the lower one is stretched forward in form of a wedge, and thence is called by some the *cuneiform* process. The several turns of the edges of the os occipitis make in fact five or seven sides, and as many angles.

The external surface is convex, except at the cuneiform apophyse, where it is flattened.

On each side of the *foramen magnum ossis occipitis*, but more advanced forwards than the middle of it, there are large oblong protuberances, named the *condyles*, by which this bone is connected with the first vertebra of the neck.

These condyles are not exactly uniform as to form and size. The smooth surface of each of these condyloid processes is longest from behind forward, where, by their oblique situation, they come much nearer to each other than they are at their back part. Their inner sides are lower than the external; thus they are prevented from sliding to either side out

of the cavities of the first vertebra *. In some subjects each of these plain smooth surfaces seems to be divided by a small rising in its middle, and the lower edge of each condyle next the great foramen is discontinued about the middle by an intervening notch: Whence some † allege, that each of these apophyses is made up of two protuberances. Round their root a small depression and spongy roughness is observable, to which the ligaments for surrounding and securing their articulations adhere.

The motion of the head is performed on the condyles, but its centre of gravity does not fall between them, but further forwards; hence the muscles which pull the head back, must be in a constant state of contraction, else the head would always fall forwards, as it does when a man is asleep, or labours under a palsy, as well as in infants, where the weight of the head far exceeds the proportional strength of these muscles. This seeming disadvantageous situation of the condyles, gives sufficient space for the cavities of the mouth and fauces, and for lodging a sufficient number of muscles, which commonly serve for other uses; but may at pleasure act on the head, and then act with an advantageous lever, so as to be capable of sustaining a considerable weight.

Somewhat more externally than the condyles, there is a small rising and semilunated hollow in each side, which make up part of the holes common to the occipital and petrous bones. Immediately behind this, on each side, a scabrous ridge is extended from the middle of the condyle, towards the root of the mastoid process. About the middle of the external convex surface, a large arch runs cross the bone; from the upper lateral parts of which the occipital muscles have their rise; to its middle the trapezii are attached; and half way between this and the great hole, a lesser arch is extended. In the hollows between the middle of these arches, the complexi are inserted; and in the depressions more external and further forward than these, the splenii are inserted. Be-

* Galen, de usu part. lib. 12. cap. 7.

† Diemerbroeck, Anat. lib. 9. cap. 6.

tween the middle of the lesser arch and the great hole, the little hollow marks of the recti minores appear; and, on each side of these, the bone is imprinted by the fleshy insertions of the obliqui superiores and recti majores.

Through the middle of the two arches a small sharp spine is placed. All round the great foramen the edges are unequal, for the firmer adhesion of the strong circular ligament which fixes it to the first vertebra. One end of each lateral or moderator ligament of the head, is fixed to a rough surface at the fore-part of each condyle, and the perpendicular one is connected to a rough part of the edge of the great hole between the two condyles. Immediately before the condyles, there are two little depressions made on the external surface of the cuneiform process for the insertion of the recti anteriores minores muscles: And still farther forward, nearer the sphenoid bone, are two other such depressions, for the reception of the recti anteriores majores. The muscles which pull the head backwards, are stronger than those which bend it forwards; and acquire greater force by the long lever they act with, than the latter, which are inserted so near the condyles. This great force in the extensor muscles is altogether necessary, not only to keep the head from falling forward, in an erect posture, but also to support it when we bow forward, when the weight of the head comes to act at right angles on the vertebræ of the neck, and with the advantage of a longer lever.

There are, on the inner surface of the os occipitis, two ridges; one is perpendicular, the other running horizontally across the first. The upper part of the perpendicular limb of the cross, to which the falx is fixed, is hollowed in the middle, or often on one side, for the reception of the superior longitudinal sinus, and the lower part of it has the small or third process of the dura mater fastened to it, and is sometimes hollowed by the occipital sinus. Each side of the horizontal limb is made hollow by the lateral sinuses inclosed in the transverse process of the dura mater; the fossa in the right side being generally a continuation of the one made by the longitudinal sinus in the perpendicular limb, and there-

fore is larger than the left one *. Round the middle of the cross there are four large depressions separated by its limbs; the two upper ones being formed by the back-part of the brain, and the two lower ones by the cerebellum.

Farther forward than the last-mentioned depressions, is the lower part of the fossa for the lateral sinus on each side. In the inner and concave surface of the cuneiform apophyse, lodges the medulla oblongata, and the basilar artery. A furrow is made on each side, near the edges of this process, by a sinus of the dura mater, which empties itself into the lateral sinus †.

There are five proper, and two holes common to this bone, and to the temporal bones. The first of the proper holes, called *foramen magnum*, from its size, is immediately behind the wedge-like process, and allows a passage to the medulla oblongata, nervi accessorii, to the vertebral arteries, and sometimes to the vertebral veins. At each side of this great hole near its fore-part, and immediately above the condyles, we always find a hole, sometimes two, which soon unite again into one that opens externally; through these the ninth pair of nerves go out of the skull. The fourth and fifth holes are placed behind, and give passage to veins of the neck which terminate in the lateral sinuses. Often one of these holes is wanting, sometimes both, when the veins pass through the great foramen. Besides these five, we frequently meet with other holes near the edges of this bone, for the transmission of veins; but their number and diameter are very uncertain.

The two common foramina are the large irregular holes, one in each side, between the sides of the cuneiform process, and the edges of the petrous bones. In a recent subject, a strong membrane runs cross from one side to the other of each of these holes; in some heads I have seen this membrane ossified, or a bony partition dividing each hole; and, in the greater number of adult skulls, there is a small sharp-pointed

* Morgagn. Advers. Anat. 6. Animad. l.

† Albin. de Ossib. sect. 65.

process stands out from the os petrosum, and a more obtuse rising in the occipital bone, between which the partition is stretched. The lateral sinus passes through the posterior and larger portion of this partition; and the eighth pair of nerves and accessory nerve pass through the smaller and anterior portion.

The occipital bone is among the thickest of the cranium, and is stronger above, where it has no other defence than the common teguments. But the under part of this bone, in which the hemispheres of the cerebellum are lodged, is so very thin, as to be diaphanous in many skulls. The occipital bone is joined above to the ossa parietalia and triquetra, when present, at the lambdoid suture; laterally by the temporal bones, by the addimenta of the lambdoid suture; below to the sphenoid bone, by the end of its cuneiform process *, in the same way that epiphyses and their bones are joined: for, in children, a ligamentous cartilage is interposed between the occipital and sphenoid bones, which gradually turns thinner, as each of the bones advances, till their fibres at last run into each other; and, about sixteen or eighteen years of age, the union of these two bones becomes so intimate, that a separation cannot be made without violence. The os occipitis is joined by a double articulation to the first vertebra of the neck, each condyle being received into a superior oblique process of that vertebra.

This bone is not often fractured, the upper and more exposed being of considerable thickness. It sometimes has happened, that the cuneiform process of this bone has been broken and beaten upwards, in consequence of a person carrying a heavy weight falling upon the upper part of the head.

In an infant born at the full time, this bone consists of four parts. The first of these is larger than the other three, is of a triangular shape, and constitutes all the part of the bone above the great foramen. Generally fissures appear in the upper part and sides of this triangular bone, when all the

* In the adult, the occipital and sphenoid bones are firmly fixed to each other; and hence Soemmering has described them under the name of Os spheno-occipitale.

cartilage is separated by maceration; and sometimes little distinct bones are seen towards the edges of it. The second and third pieces of this bone are exactly alike, and situated on each side of the great foramen, from which the condyles are produced; and are extended forwards almost to the fore-part of the hole for the ninth pair of nerves. The cuneiform process, which forms a small share of the great hole, constitutes the fourth piece; and betwixt it and the sphenoid bone a cartilage is interposed.

Os Ethmoides.

The Os Ethmoides *, or the sieve-like bone, is made up of the *cribriform lamella*, the *nasal lamella*, *cellulæ*, and *ossa spongiosa*; all which are thin layers of bone, and form an extensive surface, but occupy little space.

The thin cribriform lamella, is (except its back part) pierced obliquely by a great number of small holes, through which the filaments of the olfactory nerves pass †, which have been very minutely described by Scarpa, in his Anat. Acad.

From the middle of this plate, a thick process, called Crista Galli rises upwards; and, being highest at the fore part, gradually becomes lower, as it is extended backwards. To the ridge of *crista galli* ‡, the falx is connected to the unperforated part of the cribriform plate. When the crista is broken, its base is sometimes found to be hollow, with its cavity opening into the nose §. I have seen the *crista galli* inclined to one side, so as to cover the holes on one side of the cribriform place. Immediately before the highest part of this process, is the blind hole of the frontal bone, which is often in a great measure formed by a notch in the fore part of the root of the crista.

From the middle of the outer surface of the cribriform la-

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* Cribriforme, σπογγοειδὴς, spongiforme, cristatum.

† Vide Monro on the Nervous System.

‡ Verruca prædura, septum ossis spongiosi.

§ Palfyn. Anat. chir. tr. 4. chap. 15.

mella, a thin solid plate is extended downwards and forwards, having the same common base with the crista galli. Generally it is not exactly perpendicular, but is inclined to one side or other, and therefore divides the cavity of the nose unequally. Its inclination to one side, and flexure in the middle, is sometimes so great, that it fills up a large share of one of the nostrils, and has been mistaken for a polypus there. It is thin at its rise, and rather thinner in its middle; but towards its lower edge becomes thicker, that its conjunction with the bones and middle cartilage of the nose might be firmer. At a little distance from each side of this external process, a cellular and spongy bony substance depends from the cribriform plate. The number and figure of the cells, the uppermost of which are in form like a funnel, and communicate with each other, and with the cavity of the nose, are very uncertain.

The bone over these cells is smooth; hence these portions of it have been called *ossa plana;* on the upper edge of which, a small notch or two may sometimes be observed, which assist in the formation of the internal orbitar holes. Below the cells of each side, a thin plate is extended inwards, and then bending down it becomes thick and of a spongy texture. This spongy part is triangular, with a straight upper edge placed horizontally, an anterior one slanting from above, downwards and forwards, and with a pendulous convex one below. The upper and lower edges terminate in a sharp point behind. The side of this pendulous spongy part next to the septum narium is convex, and its external side is concave. These two processes of the ethmoid bone, from their substance, figure, and situation, have been called *ossa turbinata superiora.*

The prominences, and cavities of this ethmoid bone, are covered by a continuation of the membrane of the nostrils, in a recent subject.

The horizontal cribriform plate is lodged between the orbitar processes of the frontal bone, to which it is joined at the ethmoid suture, except at the back part, where it is connected

with the cuneiform bone, by a suture common to both these bones, though it is generally esteemed part of the sphenoidal.

Where the ossa plana are contiguous to the frontal bone within the orbit, their conjunction is reckoned part of the transverse suture. Farther forward than the ossa plana, the cells are covered by the ossa unguis, which are not only contiguous to these cells, but cannot be separated from them, without breaking the bony substance. Below the ossa unguis and plana, these cells and ossa spongiosa are overlapped by the maxillary bones. The cellular part of each palate-bone is contiguous to each os planum, and cells backwards. The lower edge of the nasal perpendicular plate is received into the furrow of the vomer. Its posterior edge is joined to the fore part of the processus azygos of the sphenoid bone. Its upper edge joins the nasal process of the frontal and nasal bones, and its anterior one is connected to the middle cartilage of the nose. This bone sustains the anterior lobes of the brain; gives passage to the olfactory nerves, and attachment to the falx; renders the organ of smelling more acute, by increasing the surface over which the membrane of the nose is extended; straitens the passage of the air through the nose, by leaving only a narrow winding canal, on the sensible membranous sides of which the substances conveyed along with the air must strike; this bone forms part of the orbit of the eyes and septum narium.

On account of the thinness of this bone, an ozæna is difficult to cure; and from violent scurvies, or the lues venerea, the fabric of the nose, the eyes, and life itself, are in danger. Fractures of the nasal plate are dangerous, when occasioned by a force applied to their middle fore-part, of a person in whom this nasal plate is perpendicular *.

The ethmoid bone of a child is divided into two, by a perpendicular cartilage, which, when ossified, constitutes the crista galli, and nasal plate.

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* Vid. also Schneider de osse cribriformi.—Santorini's obs. anat. and the 6th of Morgani adversar. anatomica.—Haller Tab. Narium internarum.—Blumenbach de Sinibus frontalibus.

Os Sphenoides.

The Os Sphenoides, or wedge-like bone, so called, because of its situation in the middle of the bones of the cranium and face.

There are two or three remarkable processes from each side of this bone. First, the two large lateral processes or wings; the upper part of each of which is called the *temporal process*, because they join with the temporal bones in forming the temples, and the seat of a share of the temporal muscles. That part of the wings which juts out towards the inside, somewhat lower than the temporal apophyses, and is smooth and hollowed, where it makes up part of the orbit, is thence named *orbitar process*. Behind the edge, separating these two processes, there is often a small groove, made by a branch of the superior maxillary nerve, in its passage to the temporal muscle. The lowest and back-part of each wing, which runs out sharp to meet the ossa petrosa, has been styled the *spinous process:* From near the point of which a sharp-pointed process is frequently produced downwards, which some call *styliform*, and affords origin to the ptery-staphylinus externus muscle. From this styloid process a very small groove is extended along the edge of the bone to the hollow at the root of the internal plate of the following process, which forms part of the Eustachian tube *. The second pair of external processes of the cuneiform bone, is the two which stand out almost perpendicular to the base of the skull. Each of them has two plates, and a middle fossa facing backwards, and should, to carry on our comparison, be likened to the bat's legs, but are commonly said to resemble the wings of that creature; and, therefore, are named *pterygoid* or *aliform* † processes. The external plates are broadest, and the internal are longest. From each side of the external plates the pterygoid muscles take their rise. At the root of each internal plate, a small

* Winslow, Exposition Anatomique du corps humain, Traité des os secs, § 233.

† Naviculares.

hollow may be remarked, where the muscle called circumflexus palati rises, and a part of the cartilaginous end of the Eustachian tube rests; and, at the lower end of the same plate, is a hook-like rising or process, round which the tendon of the last-named muscle plays, as on a pulley. From the edge of the external plates there are some small projections of bone. There is also a little triangular thin process, which comes from each side of the body of the sphenoid bone, where the pterygoid processes are rising from it, and are extended over the lower part of the aperture of the sinus as far as to join the ethmoid bone, while their body hangs down into the nares *. Besides these pairs of processes, there is a sharp ridge which stands out from the middle of its base, hence called *processus azygos*. The lower part of this process, where it is received into the vomer, is thick, and often not quite perpendicular, but inclining more to one side than the other. The fore part of this process, where it joins the nasal plate of the os ethmoides, is thin and straight. These two parts have been described as two distinct processes by some.

The depressions, sinuosities and fossæ, on the external surface of this sphenoid bone, are the two temporal, in which the temporal muscles are lodged. Two on the orbitar processes, for the eye-balls: two between the temporal and spinous processes, for receiving the temporal bones: two between the plates of the pterygoid processes, where the musculi pterygoidei interni, and ptery-staphylini interni are placed: two between the pterygoid and orbitar processes, for forming the holes common to this, and to the cheek and maxillary bones: two on the lower ends of the aliform processes, which the plate bones enter into: two at the roots of the temporal and pterygoid processes, where the largest share of the external pterygoid muscles have their rise: two at the sides of the processus azygos, for forming part of the nose, &c.

The temporal and spinous processes internally are con-

* Albin. Tab. Oss. v. Fig. 2. 6. A. A. Bertin. Mem de l'Acad. des Sciences, 1744, Sue, planche viii. Fig. 2, 3, 4, 5, 6.

cave, for lodging a part of the brain; and commonly three apophyses on the internal surface of the sphenoid bone are only mentioned. Two rising broad from the fore part of its body, become smaller as they are extended obliquely backwards; the third, standing on a long transverse base, near the back part of the body of this bone, rises nearly erect, and of an equal breadth, terminating often in a little knob on each side. The three are called *clinoid*, from some resemblance which they were thought to have to the supporters of a bed. Sometimes one or both the anterior clinoid processes are joined to the sides of the posterior one, or to the body of the bone itself. From the roots of the interior clinoid processes, the bone is extended on each side outwards and forwards, and ends in the sharp *transverse spinous process*. Between, but a little farther back than the two anterior clinoid processes, we see a protuberance considerably smaller than the posterior clinoid process, but of its shape. Another process from between the transverse processes, often forces itself forwards into the os ethmoides.

The cavities formed by the several surfaces of the temporal processes of the sphenoid bone, contain the middle lobes of the brain. Immediately before the third or middle clinoid process, a single pit generally may be remarked, from which a fossa goes out on each side to the holes through which the optic nerves pass. The pit is formed by the conjoined optic nerves; and in the fossæ these nerves are lodged, as they run divided within the skull. Between that third protuberance and the posterior clinoid process, the large pit for the glandula pituitaria may be remarked. This cavity, because of its resemblance to a turkish saddle, is always described under the name of *sella turcica*, or *ephippium*. On the sides of the posterior clinoid processes, there is a canal for lodging the internal carotid artery, that stretches upwards; then is continued forwards along the sides of the sella turcica, near to the anterior clinoid processes, where a pit on each side is made. Several other fossæ may be observed, leading to the several holes, and imprinted by the nerves and bloodvessels.

The holes on each side of the os sphenoides are six proper, and three common. The first is the round one immediately below the anterior clinoid processes, for the passage of the optic nerve, and occular artery. The second is the foramen lacerum, or large slit between the transverse spinous and orbitar processes: the interior end of which slit is large; and, as it extended outwards, it becomes narrower. The outer end of it is formed in the os frontis; and, therefore, this might be reckoned among the common foramina. Through it the third, fourth, the first branch of the fifth, and the greater share of the sixth pair of nerves, and an artery from the internal carotid, go into the orbit. Sometimes a small branch of the external carotid enters its end, to be distributed to the dura mater *, and a vein, some call it the *venus duct*, or *Nuck's aqueduct*, returns through it to the cavernous sinus. The third hole, situated a little behind the one just now described, is called *rotundum*, from its shape, which gives passage to the second branch of the fifth pair of nerves, or superior maxillary nerve. The fourth is the foramen ovale, about half an inch behind the round hole, the third branch of the fifth pair, or inferior maxillary nerve, goes out; and sometimes a vein from the dura matter passes out here †. The fifth hole of this bone, which is small and round, and gives passage to the principal artery of the dura mater, passes near to the point of the spinous process. The sixth proper hole ‡ cannot be well seen, till the cuneiform bone is separated from all the other bones of the cranium: for one end of it is hid by a small protuberance of the internal plate of the pterygoid process, and by the point of the processus petrosus of the temporal bone. Its canal is extended above the inner plate of the pterygoid process; and where it opens into the cavity of the nose, it is con-

* Winslow, Exposition Anatomique du corps humain, Traité des Artères, sect. 60. & de la Tête, sect. 26.

† Ingrass. Commentar. in Galen, de Ossib. lib. i. comment. 8.

‡ Vesal. Anat. lib. i. cap. 12. Eustach. Tab. 46. Fig. 13. 16. Vidus Vidius, Anat. lib. ii. cap. 2. Explicat. Tab. 3. & Tab. 5. Fig. 8, 9, 10. lit. O.

cealed by the thin laminous part of the palate bone. Through it a considerable branch of the second branch of the fifth pair of nerves is reflected. Often in the middle of the sella turcica a small hole or two pierce as far as the cellular substance of the bone; and sometimes at the sides of this sella, one or more small holes penetrate into the sphenoidal sinuses.

The first of the common holes is that unequal fissure at the side of the sella turcica, between the extreme point of the os petrosum and the spinous process of the cuneiform bone. This hole only appears after the bones are boiled; for, in a recent subject its back part is covered by a thin bony plate that lies over the internal carotid artery, and farther forward it is filled by a ligament, under which the cartilaginous part of the Eustachian tube is placed. The second common hole is the large discontinuation of the external side of the orbit, left between the orbitar process of the cuneiform bone, the os maxillare, malæ, and palati. In this large hole, the fat for lubricating the globe of the eye and temporal muscle is lodged, and branches of the superior maxillary nerve, with small arteries from the carotid and veins pass. The third hole is formed between the base of this bone and the root of the orbitar process of the palate-bone of each side. Through this a branch of the external carotid artery, and of the second branch of the fifth pair of nerves, pass to the nostrils, and a returning vein accompanies them. Sometimes, however, this hole is proper to the palate-bone, being entirely formed out of its substance.

Under the sella turcica, and some way farther forward, but within the substance of the sphenoid bone, are two sinuses separated by a bony plate. Each of them is lined by a mucous membrane, and opens into the upper and back part of each nostril by a round hole which is at their upper fore part. This hole is not formed only by the os sphenoides, which has an aperture near as large as any transverse section of the sinus, but also by the palate bones which are applied to the fore part of these sinuses, and close them up, that hole only excepted, which was already mentioned. Frequently the two sinuses are of unequal dimensions, and sometimes there is only one large cavity, with an opening into one nostril. These

cavities are likewise said * to be extended sometimes as far back as the great foramen of the occipital bone. In other subjects they are not to be found, when the bone is composed of large cells †. Some ‡ mention a cavity within the partition of the sinuses; but it is small.

This bone is of a very different thickness, being in some places diaphanous; in others it is of a middle thickness, and its middle back part surpasses the greatest share of the cranium in thickness.

The os sphenoides is joined by its wings to the parietal bones above, to the os frontis and ossa malarum before, to the temporal bones behind; by the fore part of its body and spinous processes, to the frontal and ethmoid bones; by its back part, behind the two sinuses to the occipital, where it looks like a bone with the epiphyses taken off, and, as was formerly observed in the description of the occipital bone, it cannot be separated without violence in adults; to the palate bones, by the ends of the pterygoid processes, and still more by the fore part of the internal plates of the pterygoid processes, and of the sinuses; to the maxillary bones, by the fore part of the external pterygoid plates; to the vomer and nasal plate of the os ethmoides, by the processus azygos.

The sphenoid bone is almost complete in a fœtus of nine months; the alæ may be separated after maceration from the body of the bone. The processus azygos is very large and hollow; the thin triangular processes are not ossified; and the sinuses does not appear.

Dr Portal ¶ has remarked, that he had several times found this bone carious in infants that had died from the small-pox. The temporal wings of this bone have sometimes, though rarely, been broken, as they are covered by the temporal muscles, and their aponeuroses.

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* Albin. de Ossib. sect. 39.

‡ Id. Ibid.

† Vesal. lib. i. cap. 6.

¶ Anat. Med. tom. i. p. 138.

CHAP. X.

OF THE BONES OF THE FACE.

THE bones of the face have been divided, by authors, into those of the upper and lower maxillæ or jaws.

The bones of the face are considerably larger in the adult, in proportion to those of the cranium, than in the infant, which are short, owing to the want of the teeth, and maxillary sinuses.

In some Negroes, the upper and under jaws are much more prominent than in the European, but not equally so.

The upper jaw of the greater number of the monkey tribe is still more prominent than that of the Negro.

Dr CAMPER has grounded his method of marking the peculiarities of national conformation of the head, by placing the skull as nearly as possible as it rests on the atlas: he then draws one line along the profile, which touches the more prominent parts of the fore head and upper jaw, this he calls *the facial line.*

He draws a second line in the opposite direction, or horizontally across the head, through the meatus auditorius externus. The angle formed at the junction of these two lines, which he has called *facial angle*, is, according to Dr CAMPER, the index of the peculiar form of the skull.

Thus he has endeavoured to prove the existence of a regular gradation, as the conformation of the skulls of different nations, and also a gradation as to form, between the human skull and that of the inferior animals *.

* CAMPER on the connection between the Science of Anatomy and the arts of drawing, painting and statuary, translated by Dr T. COGAN, from the Dutch. London, 1794.

But the above method of estimating the differences in skulls of different nations is imperfect; for it points out only those distinctions which result from the degrees of prominence of the fore head and jaws: it is liable also to insuperable objections; for there are skulls of different nations which have the same prominence of the jaws, but which are very different in other respects, and, on the other hand, there are also crania which agree in most respects as to form, but the jaws of such skulls are widely different as to the degree of prominence, and of course as to the direction of the facial line.

Beside, there are many of the nations inhabiting different parts of Africa, *whose head in form resembles that of the European;* for instance, the skull of the Kaffer Hottentot (which now lies before me) differs but little from that of the European.

The upper jaw, which is bounded above by the transverse suture, behind by the fore part of the sphenoid bone, and below by the mouth, was formerly described as consisting only of thirteen bones, viz. two *ossa nasi*, two *ossa unguis*, two *ossa malarum*, two *ossa maxillaria*, two *ossa palati*, two *ossa spongiosa inferiora*, and the *vomer*.

Bertin and Albinus have described two small additional bones, which are connected with the sphenoidal bone.

The ossa nasi are placed at the upper part of the nose; the ossa unguis are at the internal canthi of the orbits; the ossa malarum form the prominence of the cheeks; the ossa maxillaria form the side of the nose, with the lower and fore part of the upper jaw, and the greatest share of the roof of the mouth; ossa palati, are situated at the back part of the palate, nostrils, and orbit; ossa spongiosa are seen in the lower part of the nares; and the vomer forms a part of the partition of the nose.

The bones of the upper jaw are connected to each other by gomphosis and fifteen sutures.

The first is the *anterior nasal*, which is straight, and placed longitudinally in the middle fore part of the nose.

The second and third are the *lateral nasal*, which are at each side of the nose, and almost parallel to the first suture.

Each of the two *lacrymal* is almost semicircular, and is placed round the lacrymal groove.

The sixth and seventh are the *internal orbitar ;* each of which is extended obliquely from the middle of the lower side of an orbit to the edge of its base.

The two *external orbitars* are continued, each from the end of the internal orbitar, to the under and fore part of the cheek.

The tenth is the *mystachial*, which reaches only from the lower part of the septum narium, to between the two middle dentes incisores.

The *longitudinal palate* suture stretches from the middle of the foremost teeth through the middle of all the palate.

The *transverse palate* one runs across the palate, nearer the back than the fore part of it.

Each of the two *palato-maxillary* is at the back part of the side of each nostril.

The fifteenth is the *spinous*, which is in the middle of the lower part of the nostrils. This may, perhaps, be rather thought a double schindylesis.

The ossa spongiosa are connected to the side of each nostril, by a membrane in young subjects, by a sort of hook, and in adults by a bony union.

The indentations of the sutures of the face, (formerly called *harmoniæ*), are not so conspicuous as those of the upper part of the skull ; there being less necessity for security against external injuries, or any internal protruding force. These sutures often disappear in old age.

From the manner of the conjunction of these bones, they can have no motion, except in common with the cranium.

Ossa Nasi.

The Ossa Nasi so named from their situation at the root of the nose, are each of an irregular oblong square figure, being broadest at their lower end, narrowest a little higher than

their middle, and becoming somewhat larger at the top, where they are ragged and thickest, and have a curvature forwards, that their connection with the frontal bone might be stronger. These bones are convex externally, and thereby better resist any violence from without; and they are concave internally, for enlarging the cavity of the nose.

The lower edge of these bones is unequal, and is stretched outwards and backwards, to join the cartilages of the nostrils. Their anterior side is thick, especially above, and unequal, that their conjunction to each other might be stronger; and a small rising may be remarked on their inner edge, where they are sustained by the septum narium. Their posterior side, at its upper half, has externally a depression, where it is overlapped some way by the maxillary bones, while its lower half covers these bones: Thus they do not yield easily to pressure applied to their fore part or sides.

A small hole is frequently to be observed on their external surface, into which two, three, or four, holes, which appear internally, terminate, for the transmission of small veins: sometimes the holes go no farther than the cancelli of the bones.

The inhabitants of Java *, Hottentots, Brasilians †, Negroes, and South Sea Islanders ‡, endeavour to compress the nose immediately after birth, conceiving a broad flat nose to be conducive to beauty. It is probable that a similar custom has prevailed in Egypt, for the breadth of the base of the nose of the figures carved in stone brought from that country is remarkable. But the flatness of the Negro nose is an original conformation; a fact which has been fully established by the concurrent testimonies of CAMPER, SOEMMERING, and BLUMENBACH. The latter author has represented the cranium of a Negro child and a Burat child, with all the characteristic marks of the Ethiopian and Mongolian adult skull.

* MARSDEN'S History of Sumatra, p. 44.

† De LERY, Voyages en la Terre du Brasil, p. 98.

‡ FORSTER'S Voyage Round the World, p. 593.

In the nasal bones there are few cells; they are firm and solid.

They are joined above to the frontal bone, by the middle of the transverse suture; behind, to the maxillary bones, by the lateral nasal sutures; below, to the cartilages of the nose; before, to one another, by the anterior nasal suture; internally, to the septum narium.

These bones serve to cover and defend the root of the nose.

In an infant, the nasal bones are proportionally shorter and thinner at their upper part, than in an adult, and porous on the internal surface.

Fractures of the ossa nasi are not so frequent as might have been expected from their exposed situation. Generally both bones are broken; there are, however, instances in which the fracture has been limited to one of them.

A fracture of one or both of the bones of the nose is generally accompanied by a fracture of the nasal plate of the ethmoidal bone; and consequently, by considerable bleeding, inflammation and swelling of the softer parts of the nose: and I have seen instances in which the crista galli had been beaten upwards into the substance of the brain. Though the broken pieces of these bones are not apt to be disunited by the action of muscles, they are apt to be disunited by falling inwards, which has led to a proposal of putting into the nostrils dossils of lint, besmeared with hog's-lard, which, however, are but of little use.

Ossa Unguis.

The Ossa Unguis, or lacrymalia, are so named, from their resemblance in figure and magnitude to the nail of the finger, and because the tears pass upon them into the nose.

Their external surface is composed of two smooth concavities and a middle ridge. The depression behind forms a small share of the orbit, and the one before is a deep perpendicular canal, or fossa, larger above than below, containing part of the lacrymal *sac* and *duct*. This part ought to be

pierced in the operation for the *fistula lacrymalis* *. This fossa of the bone is cribriform, or has a great number of small holes through it, for the filaments of the membrane which lines it. The ridge between these two cavities of the os unguis, is the proper boundary of the orbit at its internal canthus. The internal or posterior surface of this bone consists of a furrow in the middle of two convexities.

The substance of the os unguis is as thin as paper, and very brittle; it is easily pierced in living subjects.

Diseases of the lacrymal sac very often give rise to caries of the os unguis, and sometimes, also, to that of the neighbouring bones.

In the Negro skull the fossa for the nasal duct is considerably deeper than in the European.

Each of these bones is joined above to the frontal bone, by part of the transverse suture; behind, to the os planum of the ethmoid bone, by the same suture; before, and below, to the maxillary bone, by the lacrymal suture. Internally, the ossa unguis cover some of the sinus ethmoidales; nay, are really continuous with the bony lamellæ which make up the sides of these cells.

The ossa unguis form the interior internal parts of the orbits, lodge a share of the lacrymal sac and duct, and cover the ethmoid cells.

These bones may be injured in performing the operation of the fistula lacrymalis.

These bones are fully formed in a new-born child.

Ossa Malarum.

The Ossa Malarum †, in point of form, are prominent and square. These bones are generally larger in the Scotch than in the English: they are small in the Circassian and Hindoo; but remarkably large in the skulls of the Turk, New Hollander, African, Eskimaux, and Norwegian. Before, their

* See an account of the disease called *Fistula lacrymalis*, in the Works of Dr Monro *primus*, p. 522.

† Jugalia vel zygomatica, hypopia, subocularia.

surface is convex and smooth; behind, it is unequal and concave, for lodging part of the temporal muscles.

The four angles of each of these bones have been reckoned processes by some authors. The one at the external canthus of the orbit, called the *superior orbitar* process, is the longest and thickest. The second terminates near the middle of the lower edge of the orbit in a sharp point, and is named the *inferior orbitar* process. The third, placed near the lower part of the cheek, and thence called *maxillary*, is the shortest, and nearest to a right angle. The fourth, which is called *zygomatic*, because it is extended backwards to the zygoma of the temporal bone, ends in a point, and has one side straight, and the other sloping. Between the two orbitar angles, there is a concave arch, which makes about a third of the external circumference of the orbit, from which a fifth process is extended backwards within the orbit, to form near one-third of that cavity; and hence it may be called the *internal orbitar* process. From the lower edge of each of the ossa malarum, which is between the maxillary and zygomatic processes, the masseter muscle takes its origin; and from the rough exterior part of the zygomatic process, the zygomatic muscles take their rise.

On the external surface of each cheek-bone, there are one or more small holes, for the transmission of small nerves or bloodvessels, from and sometimes into the orbit. On the internal surface there are small apertures for the passage of the nutritious vessels of these bones. A notch on the outside of the internal orbitar process of each of these bones, assists to form the great slit common to this bone, and to the sphenoid, maxillary, and palate bones.

The substance of these bones is, in proportion to their bulk, thick, hard, and solid; and hence, from this circumstance, and their convex form, they are seldom broken, though much exposed to external violence.

Each of the ossa malarum is joined, by its superior and internal orbitar processes; to the os frontis, and to the orbitar process of the sphenoid bone, by the transverse suture. By the edge between the internal and inferior orbitar processes,

to the maxillary bone, by the internal orbitar suture; by the side between the maxillary and inferior orbitar process, again to the maxillary bone, by the external orbitar suture; by the zygomatic process to the os temporum, by the zygomatic suture.

In infants the cheek-bones are entire, and fully ossified.

Ossa Maxillaria Superiora.

The Ossa Maxillaria Superiora, which are irregular in form, constitute the far greater part of the upper jaw.

There are seven processes of each os maxillare. The first is the long nasal one at its upper and fore part, which is broad below, and turns smaller, as it rises upwards to make the side of the nose. At the root of this, a transverse ridge may be observed within the nostrils, which supports the fore-part of the upper edge of the os spongiosum inferius. The second or orbitar is produced backwards and outwards, from the root of the nasal process, to form the lower side of the orbit. The edge of this orbitar process, and the ridge of the nasal one, which is continued from it, form a considerable portion of the external circumference of the orbit. From the proper orbitary process, a very rough triangular surface, called Malar Process, is extended downwards and outwards, to be connected to the cheek-bone; from the lowest protuberant part of which a part of the masseter muscle takes its rise. Behind the orbitar process, there is a large tuberosity, or bulge of the bone, called the Fourth Process. I have seen this process destroyed by a polypus growing within the antrum maxillare, so that the tumour hung backward into the throat. On the internal part of the tuberosity, there is often a ridge, almost of the same height with that in the nasal process, which runs transversely, and is covered by a similar ridge of the palate-bone, on which the back-part of the upper edge of the os spongiosum inferius rests. The convex back part of this tuberosity is rough, for the origin of part of the external pterygoid muscle *, and more internally is scabrous, where the

* Albin. de Ossib. sect. 79.

palate and sphenoid bones are joined to it. The alveolar, at the lower circumference of this bone, is reckoned the fifth. The sixth is the horizontal plate, which forms the greater part of the base of the nostrils, and roof of the mouth; its upper surface, which belongs to the nostrils, is very smooth, but the other below is arched and rough, for the more firm adhesion of the membrane of the mouth, which is stretched upon it. The seventh rises like a spine from the inner edge of the last, and forms a small part of the partition of the nostrils.

The depressions in each maxillary bone are, 1. A sinuosity behind the orbitar process, made by the temporal muscle. 2. A pit immediately before the same process, where the origin of the musculus elevator labiorum communis, and elevator labii superioris, with a branch of the fifth pair of nerves, are lodged securely. 3. The hollow arch of the palate. 4. The semicircular great notch, or entry to the lower part of the nostrils, betwixt the root of the nasal process and spine of the palate plate. Below this, the fore-part of the bone is flat, or sometimes hollowed by the musculus depressor labii superioris. 5. Sockets for the teeth; The number of these sockets is uncertain; for all persons have not the same number of teeth, and the four backmost teeth of each side of each jaw vary greatly in their number of roots; and when the teeth of a living person fall out, or are taken away, the sockets are filled up with an osseous net-work, which becomes solid afterwards. 6. The lacrymal fossa in the nasal process, which assists the os unguis to form a passage for the lacrymal duct. The part of the bone forming this fossa, is thick, and cannot be readily *perforated*. Immediately on the outside of this, there is a small depression, from which the inferior or lesser oblique muscle of the eye has its origin. 7. The canal on the upper part of the great tuberosity within the orbit, which is almost a complete hole; in this a branch of the superior maxillary nerve passes.

Besides these, the superior surface of the great bulge is concave, to receive the under part of the eye.

Immediately above the transverse ridge in the nasal process, a small hollow is formed by the os spongiosum. In some

subjects, the nasal process has a small round pit above the lacrymal duct, where the little tendon or ligament of the orbicular muscle of the eye-lids is inserted. It is this tendon, and not the tendon of the larger oblique muscle of the eye, which there is some hazard of cutting in the operation of the fistula lacrymalis.

The holes of this bone are two proper and two common, besides several others, the size, and number, &c. of which vary in different individuals. The first of the proper is the external orbitar, immediately below the orbit, by which the infra-orbitar branch of the second branch of the fifth pair of nerves, and a small artery, come out, after having passed in the canal, at the bottom of the orbit, described Numb. 7. of the depressions. The infra-orbitar nerve in some instances, divides into two branches; in that case there are two canals. The second is the foramen incisivum, just behind the fore-teeth, which, at its under part, is one irregular hole common to both the maxillary bones when they are joined; but, as it ascends, soon divides into two, three, or sometimes more holes; some of which open into each nostril, through which small arteries and veins, and a twig of the second branch of the fifth pair of nerves, pass. The ducts that pass through the foramen incisivum, have been particularly described by my Father:—"In quadrupeds, as in the ox and sheep, there two large canals open at both ends, and passing obliquely downwards from the nose into the mouth. In far the greater number of human subjects of different ages, I have not been able to find a vestige of such ducts, in the bottom of the nose, or roof of the mouth; but, in a few subjects, I have found them open at both ends, but always very much smaller than in the quadruped. In some of these, I passed a bristle very readily from the nose into the mouth. In two or three subjects, I first poured quicksilver from the nose through the ductus incisivus into the mouth, and then, with a small syringe, injected through it melted wax coloured with vermilion *. In some subjects, Steno's duct may be traced some way on the

* Vide Three Treatises on the Brain, the Eye, and the Ear, p. 142.

side of these passages next to the nose, and small orifices may be observed opening into the mouth."

The first common hole is that at the inner side of the back part of the tuberosity and of the sockets of the teeth, which is formed by a fossa in this bone, and a corresponding one in the os palati: Through it a nerve, which is a branch of the second branch of the fifth pair, runs to the palate. The other common hole is the great slit described already, as the second common hole of the sphenoid bone.

On the nasal process often holes may be observed, for the passage of vessels to the substance of the bone; and, at the back-part of each tuberosity, several foramina are placed, for the transmission of nerves to the cavity within.

There is a large sinus in the body of the maxillary bone, which is commonly called *antrum maxillare.*

The size and form of the antra maxillaria vary very much in different individuals of the same age, and in persons of different ages, and in different nations; for in the child at birth, they can be scarcely said to exist, and it also merits mention, that in the same individual they are seldom of the same size. I have seen these small and compressed in the skull of an Eskimaux, and in that of a native of Van Dieman's Land. In a rickety skeleton of an adult, in the possession of my colleague Dr Hamilton, the face appears remarkably long and narrow, which, upon examination, was owing to the opposite sides of the antra maxillaria being almost in contact; and it may be observed, that the impressions made by the muscles of the face were unusually deep.

When the os maxillare is separated from all the other bones of a skeleton, its antrum appears to have a large aperture into the nostrils; but, in a recent subject, it is so covered at its back-part by the palate bone, in the middle by the os spongiosum inferius, before, by a strong membrane, that one, or sometimes *two holes, scarce larger than a crow-quill, are only left at the upper part;* which, after a short winding progress, open into the nostrils between the two ossa spongiosa.

This cavern, and the sockets of the teeth, are often divided by the interposition only of a very thin bony plate, which is liable to be eroded by acrid matter collected in the antrum, or to be broken in drawing a tooth *. Matter collected within the antrum may be discharged by pulling out the teeth, and piercing through this plate into the antrum.

The extremities of the roots of the teeth sometimes perforate the floor of this cavity; hence, when it is the object of the surgeon to let out purulent matter contained within it, all that is necessary is to extract the second or third grinding tooth.

A thin mucous membrane, continued from that which lines the bones of the nose, lines the antrum. Polypi sometimes grow from the mucous membrane lining the antrum, and occasion an enlargement and distortion of the cavity, and, by raising the orbitar process of the bone, the eye-ball is more or less pushed out of its socket.

Fungi of the antra maxillaria are by no means unfrequent. These occasion very great distortion of the face, a protrusion of the eye-ball, impede the flow of tears into the nose, and cause a discharge of a sanious fluid from the nostrils.

The bones in the vicinity of the antrum are ultimately destroyed, and the fungus protrudes through the palate and alveolary processes, or through the cheek.

The maxillary bones are joined above by the upper ends of their nasal processes to the os frontis, by the transverse suture; at the sides of these processes, to the ossa unguis, by the lacrymal sutures; to the nasal bones, by the lateral nasal sutures; by their orbitar processes, to the cheek-bones, by the external orbitar sutures; by the internal sides of the internal orbitar processes, to the ossa plana, by part of the ethmoidal suture; by the back-part of the tuberosities, to the palate-bones, by the suturæ palato-maxillares; by the posterior edges of their palatine lamellæ, to the ossa palati, by the transverse palate suture; by their nasal spines, to the vomer,

* Highmore, Disquis. Anat. lib. 3.

† Cowper, in Drake's Anthropol. Book 3. chap. 10. Medical Essays and Observ. vol. v. Art. 30.

by the spinous suture; by their sockets, to the teeth by gomphosis; by the internal edge of the palate-plate, to one another, by the longitudinal palate suture, on the upper and fore-part of which a furrow is left for receiving the cartilage which forms the partition of the nostrils; between the fore-part of the nostrils and mouth, to each other, by the mystachial suture; sometimes they are connected to the ossa spongiosa inferiora, by a plain concretion of union of substance.

In each of the maxillary bones, of a newborn child, the external orbitar process is hollow, with remarkable holes in it; there are five sockets for the teeth, of which the two posterior are very large, and, when divided by a second cross partition, make the number of sockets six *. The palate plate is cribriform about the middle.

The superior maxillary bone is much shorter in the fœtus than in the adult, and the palatine process of it, instead of being arched, is nearly flat, and on a level with the alveolar surface. There is scarcely an appearance of the antrum maxillare; hence the remarkable change produced upon the face by the expansion of that sinus; the nose is raised, and is lengthened; the cheek bones become prominent, and, by the addition of the teeth, the face becomes much longer.

In some mammalia, there is a wedge-shaped bone, or two bones, which contain the incisor teeth, which has been called, therefore, the *intermaxillary bone*, or ossa incisiva. But as this or these bones are found in the elephant, ant-eater, and in some whales, that have not incisor teeth, the intermaxillary is the more appropriate name.

Dr Camper and Blumenbach found this bone in some, but not in all the simiæ.

Ossa Palati.

These bones form the back-part of the palate, nostrils, orbits, pterygoid fossæ, and cover part of the maxillary, sphenoidal, and ethmoidal sinuses. Each palate-bone may be di-

* Albin. Osteogen. Tab. 5. Fig. 45. Ungebav. de Dentit. secund. jun. § 1.

vided into four parts; the palate square-bone; the pterygoid process; nasal lamella, and orbitar process.

The square bone is unequally concave; thus more space is given for the mouth and cavity of the nose. The upper part of its internal edge rises into a spine, after the same manner as the palate-plate of the maxillary bone does, to be joined with the vomer.

Its anterior edge is unequally ragged, for its firmer connection with the palate process of the os maxillare. The internal edge is thicker than the rest, and of an unequal surface, for its conjunction with its fellow of the other side. The posterior and thicker extremity of this bone, describes a figure like a crescent, with which the velum pendulum palati is firmly connected; the internal point being produced backwards, to afford origin to the azygos uvulæ muscle. The square bone is separated from the pterygoid process by a perpendicular fossa, which, applied to such another in the maxillary bone, forms a passage for the palatine branch of the fifth pair of nerves; and by another small hole behind this, through which a twig of the same nerve passes.

The pterygoid process is somewhat triangular, having a broad base and a narrow upper end. There are three fossæ on the back part of this process; the two lateral receive the ends of the temporal processes of the sphenoid bone; the middle fossa makes up part of what is commonly called the *fossa pterygoidea;* the fore-side of this palatine pterygoid process is an irregular concave, and to it the back part of the great tuberosity of the maxillary bone is connected. Frequently several small holes may be observed in this triangular process, particularly one near the middle of its base, which a little above communicates with the common and proper holes of this bone.

The nasal lamella of this bone is extremely thin and brittle, and rises upwards from the upper side of the external edge of the square-bone, and from the narrow extremity of the pterygoid process; where it is so weak, and, at the same time, so firmly fixed to the maxillary bone, as to be very liable to be broken, in separating the bones. From the part

where this plate rises, it runs up broad on the inside of the tuberosity of the maxillary bone, to form a considerable share of the sides of the maxillary sinus, and to close up the space between the sphenoid and the great bulge of the maxillary bone, where there would otherwise be a large slit opening into the nostrils *. Dr Monro *2dus*, in his Lectures, used to observe, that " some anatomists, from observing the situation of the palate-bone, pretend to explain, what is true in practice, that diseases, the venereal for instance, after affecting the palate, readily fall upon the orbit. But rather than attribute this to the extent of the palate-bone, we are to look for a sameness of the membrane or of the bone; for we find that certain membranes and bones are more readily affected by diseases than others †." From the middle internal side of this thin plate, a cross ridge placed on a similar ridge of the maxillary bone is extended; on it, the back part of the os spongiosum inferius rests. Along the outside of this plate, the perpendicular fossa made by the palate nerve is observable.

At the upper part of this nasal plate, the palate bone divides into two orbitar processes; between which and the body of the sphenoid bone, that hole is formed, which is the last of the holes common to the sphenoid bone. Sometimes this hole is wholly formed in the os palati, by a cross plate going from the one orbitar process to the other. A nerve, artery, and vein, belonging to the nostrils, pass here. The anterior of the two orbitar processes is the largest, and has its forepart contiguous to the back-part of the maxillary sinus, and its upper surface appears in the bottom of the orbit, behind the back part of the os maxillare and planum. It has cells behind resembling those of the ethmoid bone, to which it is contiguous; it is placed on the aperture of the sinus sphenoidalis, so as to leave only a round hole at its upper fore part. The other part of the orbitar process is extended along the internal side of the upper back part of the maxillary tuberosity, to the base of the sphenoid bone, between the root of

* Albin. de Ossib. sect. 88.

† See Copy of his Lectures, written by Thornburn.

the processus azygos and the pterygoid process. "When the matter of an ulcer of the internal canthus of the eye eats through the ligamentous membrane, which connects the edge of the orbit to the eye, it naturally falls to the under part of the apex of the conical orbit, where the orbitar process of the palate-bone is; and once it is rendered carious, the caries proceeds downwards in the same bone to the part of it which forms the palate, and erodes it, and the membrane that covers it*."

The square part of this palate-bone, and its pterygoid process, are firm and strong, with some cancelli; but the nasal plate and orbitar processes are very thin and brittle.

The palate-bones are joined to the maxillary, by the fore-edge of the square part of the palate-bone, by the transverse palate suture: By their thin nasal plates, and by part of their orbitar processes, to the same bones, by the palato-maxillary sutures: By their pterygoid processes, and back-part of the nasal plates, to the sphenoid bone, by the sphenoid suture: By the transverse ridges of the nasal plates, to the ossa spongiosa inferiora, by contact; hence frequently there is an intimate union of the substance of these bones in old skulls: By the orbitar processes, to the ossa plana and cellulæ ethmoideæ, by the ethmoid suture: To the body of the sphenoid bone, by the sphenoid suture: By the internal edge of the square bones to each other, by the longitudinal palate suture; and by their nasal spines to the vomer, by the spinous suture.

These bones are very complete in a new-born infant, the nasal plates being then thicker and stronger than in adults; but there are no orbitar processes, as in the bones of adults.

From what has been stated, the cause is obvious, why the eyes are so much affected in ulcers of the palate, as to be often attended with blindness, which frequently happens in an ill-managed *lues venerea;* or why, on the other hand, the palate suffers from an *ægylops* †.

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* These Observations occur in my Grandfather's Commentary on his Osteology.

† Hoffman, in Ephemerid. German. cent. 1. and 2. observ. 135.

Ossa Turbinata.

The manner of connection of these bones, was misunderstood by the older anatomists, and ALBINUS was the first author who has accurately described their mode of connection. Instead of being merely fixed by membrane to the nose in the young subject, and growing to it in advanced life, as the older authors have stated, there is a hook, by which these bones hang upon the edge of the antrum maxillare.

The ossa turbinata, or spongiosa inferiora, resemble the superior ossa spongiosa in shape and substance, and their anterior and upper edges are contiguous to the transverse ridges of the nasal processes of the maxillary and palate bones. From their upper straight edge, two small processes stand out: The posterior, which is the broadest, descends to cover some of the antrum highmorianum; the anterior rises up to join the os unguis, and to make part of the lacrymal duct.

Below the spongy bones already mentioned, there are sometimes two others, one in each nostril, which seem to be a production of the sides of the maxillary sinus turned downwards *. When this third sort of spongy bones is found, the middle one of the three in each nostril is the largest, and the lowest is the smallest. Besides all these, there are often several other small bones standing out into the nostrils, that, from their shape, might also deserve the name of *turbinata*; but their bulk, situation, and number vary †.

There are a number of foveoli, but no holes in the os turbinatum inferius. These bones are sometimes considerably swollen, in consequence of lues venerea and scrofula.

They are joined to the ossa maxillaria, palati and unguis, in old subjects, by a firm union of substance; and as this happens also frequently in people of no great age, some ‡ are of opinion, that they should be esteemed part of the palate-bones.

These bones straiten the nostrils, extend the organ of smelling, cover part of the antra maxillaria, and assist in forming

* COWPER in DRAKE's Anthropolog. book 3. chap. 10.

† SANTORIN. Observat. Anatomic. cap. 5. § 9. ‡ Id. ibid. cap. 5. § 7.

the under part of the lacrymal ducts, the orifices of which into the nose are concealed by these bones.

The ossa turbinata are nearly complete in a new-born infant.

Vomer.

The Vomer, or bone resembling a plough-share, is the thirteenth of the upper jaw, without a fellow, forming the lower and back parts of the partition of the nose *.

The figure of this bone is an irregular rhomboid. Its sides are flat and smooth. Its posterior edge appears in an oblique direction at the back part of the nostrils. The upper one is firmly united to the base of the sphenoid bone, and to the nasal plate of the ethmoid; and, when it can be got separated, is hollow, for receiving the processus azygos of the sphenoid. The anterior edge has a long furrow in it, where the middle cartilage of the nose enters. The lower edge is firmly united to the nasal spines of the maxillary and palate bones. The edges of this bone are much thicker than the middle, which is as thin as the finest paper; and more especially in the skulls of persons advanced in life.

This bone often inclines to one side, as well as the nasal plate of the ethmoid bone.

The convexity of the vomer in one of the nostrils has sometimes been mistaken for a polypus in the nose, when that membrane has attained an unnatural thickness.

The vomer is convex at its upper part, and then is straight, as it is extended downwards and forwards, where it is composed of two plates; the edges of which have a great number of small processes, disposed somewhat like the teeth of a saw, but more irregularly, and several of them are reflected back. Between these plates a deep fossa is left, which, as far as the top of the curvature, is wide, and has strong sides, for receiving the processus azygos of the sphenoid bone. Beyond the arch forwards, the fossa is narrower and shallower gradually to the point of the bone, receiving for some way the nasal lamella ethmoidea; which, after the ossification is complete,

* Columb. de Re Anat. lib. 1. cap. 8. Fallop. Observat. Anatom.

is so closely united to the vomer by the little processes piercing into its substance, as to prevent any separation; on which account it has been esteemed by some * a part of the ethmoid bone. The middle cartilage of the nose fills up what remains of the fossa at its fore part.

The posterior edge of the vomer, which appears above the back part of the palate-bones, is broader above; but as it descends forwards, becomes thinner, though it is still solid and firm. The lower edge of this bone, which rests on the nasal spine of the palate and maxillary bones, has a little furrow on each side of a small middle ridge, answering to the spines of the bones of different sides, and the interstice between them. This edge, and the upper one, meet in the pointed fore end of this bone.

The body of the vomer has a smooth surface, and solid, but thin substance; and towards its sides, where it is thickest, some cancelli may be observed, when the bone is broken.

It is joined above to the sphenoid and ethmoid bones, and to the middle cartilage of the nose, by schindylesis; below, to the maxillary and palate bones, by the spinous suture.

The vomer divides the nostrils, enlarges the organ of smell, and sustains the palate plates of the maxillary and palate bones, which otherwise might be in hazard of being pressed into the nostrils; while the vomer is secured from shuffling to one side or other by the double schindylesis, by which it is joined to the bones above and below.

Lower Jaw.

The Maxilla Inferior, the lower jaw, is very various as to its space and thickness in different individuals, and in different nations. It is somewhat of the figure of the Greek letter υ; and situated at the lower part of the face, with its convex middle part forwards, and its legs stretched back. It is commonly divided into the chin, sides, and processes.

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* Vesalius, Santorini, Petit in his edition of Palfyn's Anatomy; and also Lieutaud, have described this bone as a part of the ethmoid bone; and Vidus Vidius, as a part of the sphenoid bone.

That part of the side of the under jaw which is covered by the masseter muscle, is rather broader in the Negro than in the European, and there is a ridge at the insertion of the muscle.

The chin is the middle fore part, the extent of which to each side is marked on the external surface by the holes observable there, and internally by the beginning of an oblique ridge.

On the fore part of the chin, a transverse ridge appears in the middle, on each side of which, the musculi depressores labii inferioris, and the levatores labii inferioris, imprint the bone.

There are always two, and sometimes three small protuberances in the middle of the back part of this bone, which has been sometimes called the symphysis of the lower jaw. These have sometimes been called the internal spines. To the uppermost when it is seen, the frænum of the tongue is connected. From the middle one, the musculi genioglossi rise; from the lowest, the geniohyoidei have their origin; and below the last, there are two rough sinuosities formed by the digastric muscles.

At the lower and fore part of the external surface of each side of the lower jaw, a small eminence may be observed, which gives rise to the depressor labiorum communis. Near the upper edge of the side a ridge runs lengthwise, to which the under part of the musculus buccinator is connected. Internally, towards the upper edge of each side, there is a second ridge, from which the mylohyoidei have their origin, and to which the internal membrane of the gums adheres.

In the upper edge of both chin and sides, there are generally sixteen sockets, for the roots of the teeth. The sockets of the teeth, which are of a spongy nature, are frequently broken in drawing the teeth, and there have been instances in which the fracture extended some way longitudinally in the jaw, and which was followed by caries and exfoliation of a large portion of it.

After the teeth have fallen out, the greater share of the

alveolar process is absorbed, and the edges of what remains of these processes fall together, forming a sharp ridge, and a sort of substitute for the teeth, which is very useful in manducation, and the jaw becomes much narrower. Hence the chin and nose of edentulous people are much nearer than before the teeth were lost; while their lips fall in towards the mouth. When new teeth are protruded, new sockets are formed.

The lower edge of the chin and sides is smooth, and has commonly been called the *base* of the lower jaw.

The ends of the base, where the jaw turns upwards, are called its *angles;* the external surface of each of which is unequal and deeply impressed by the masseter muscle. The internal surface of this bone is much marked by the insertion of the external pterygoid muscle, especially in the skull of the Esquimaux; and also by the ligament which passes between it and the styloid process of the temporal bone.

The ascending portion of the bone ends in two large processes, the coronoid and the posterior processes or condyles: the latter terminate in an oblong smooth head, supported by a cervix. The heads, whose greatest length is transverse, and whose convexity is turned forwards, are tipped with a cartilage, as the articulated parts of all other moved bones are.

The root and neck of the condyloid process are a little hollow and rough, where the external pterygoid muscles are inserted.

There are two foramina on each side of the lower jaw. The larger situated at the origin of the coronoid and condyloid processes, gives passage to the principal part of the third branch of the fifth pair of nerves, and to an artery which supplies the jaw, and a corresponding vein. A small sharp process frequently juts out backwards from the edge at the forepart of this hole, to which a ligament extended from the temporal bone is fixed *. From the lower side of this hole, a small superficial canal or a furrow descends, in which a branch of the inferior maxillary nerve is lodged, in its way to the my-

* Weitbrecht Syndesmolog. fig. 321.

lo-hyoideus muscle and sublingual gland. The other hole is external, at the confines of the chin, where small branches of the nerve and vessels come out, and are distributed on the skin and muscles of the chin.

There is a canal betwixt these two holes, in the middle of the substance of the bone, which is pierced by a great number of small holes, through which the nerves and bloodvessels of the cancelli and teeth pass. This canal is continued a little farther than the external hole at the chin.

It is remarkable, considering the size of the inferior maxillary nerve, that fractures of the lower jaw are seldom attended with bad consequences.

The surface of the lower jaw is hard and firm, except at the spongy sockets, where, however, it is stronger than the upper jaw. Its internal substance is cellular, without any solid partition between the cancelli in its middle. At the base, especially of the chin, where this bone is most exposed to injuries, the solid sides of it are thick, compact and hard.

This bone is frequently broken, in consequence of external violence. It is sometimes broken in a direction perpendicular to the basis, or obliquely, or longitudinally. I have also seen one-half of the bone completely detached by a fall from horseback, and the place of the portion thus removed was supplied in the course of six months.

The ascending branches and condyles of the jaws have also been occasionally broken. In some instances, the alveolar processes have been detached from the body of the bone. The condyloid processes, covered with cartilage, are articulated with the temporal bones. The fore-part of the cavity between the zygomatic, auditory and vaginal processes, and also the adjoining tubercle at the root of the zygomatic process of each os temporum, is covered with a smooth cartilage, for this articulation. Within this joint there is an *intermediate moveable cartilage*, which being thin in the middle, and thick at the edges, is concave on both sides; and is connected so firmly by ligaments to each condyle, as to follow the motions of the condyle; and so loosely to the temporal bone, as readily to

change its situation from the cavity to the tubercle, and to return again: while the common ligament of the articulation affords space enough for such a change of place backwards and forwards: but like other ligaments of the joints by ginglimus, is strong and short at the sides, to confine the lateral motions.

When therefore the teeth of both jaws are in contact, the condyles are lodged securely in the temporal cavities, but the lateral motions must be confined both by the firmness of the ligaments, and the rising brims on each side of the cavities. When the jaw is brought directly forwards, the condyle and intermediate cartilages descend and advance forwards upon the tubercles. In this situation the lateral motions are a little more free, owing to the want of rising brims to stop the condyles.

When the fore-teeth of the lower jaw are moved forwards, and to one side, the condyle of the opposite side is either advanced from the cavity to the tubercle, while the condyle of the same side remains in the cavity; or if both condyles are on the tubercles, when the jaw is moved obliquely to one side, the condyle of the side to which the motion is made, slides back from the tubercle to the cavity. When the mouth is opened by the descent of the lower jaw, the fore-part of it, where the depressing muscles are fixed, is drawn backwards, as well as downwards, while resistance is made to the angles moving backwards by the masseter and internal pterygoid muscles, and, at the same time, the external pterygoid muscles draw the condyles and their moveable cartilages forwards: therefore, when the mouth is opened, the condyles are carried forwards upon the tubercles, and the axis of motion of the bone is a little above its angles. But in this situation there is less resistance, than in any other, to the condyles slipping forwards; which seldom happens, except in yawning excessively, or when a blow is received upon the jaw when the mouth has been opened.

Sir A. Cooper has described the partial dislocation of the under jaw, and also the laxation: in the former, the dislocation of one of the condyles takes place, and the chin is

thrown to the side opposite to the luxation, and the incisor teeth are not in a line with the axis of the face; but, in the latter, or partial luxation, the consequence of relaxation, the condyle quits the interarticular cartilage of the temporal cavity, slipping before its edge, and locking the jaw with the mouth slightly opened. It generally happens that this state is quickly removed by natural efforts alone *.

Exostoses of a very considerable size sometimes grow from the under jaw.

In a child borne to the full time, the lower jaw *is composed of two bones*, connected by a thin cartilage in the middle of the chin. In each of these bones, there are five or six sockets for teeth as in the upper jaw.

The two pieces which compose the under jaw may be separated by pulling the chin during difficult labour. In early life the coronoid and condyloid processes are shorter proportionally than in the adult, and do not form with the body of the under jaw an acute angle as in the meridian of life, but ascend obliquely. The bodies of the teeth are lodged in the alveolar processes, with a second set beneath them; and as we get more teeth the jaws are elongated.

In old age, in consequence of the teeth falling out, the alveolar processes are, in a great measure, absorbed; the jaws lose considerably of their breadth, the angle of the jaw returns to its infantile form, and the under jaw projects considerably beyond the upper †.

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* Vide Page 393. of the 1st edition of his Treatise on Dislocation.

† For a more full account of the articulation of the lower jaw, vid. Edinburgh Medical Essays and Observ. vol. 1. art. 11. and vol. 3. art. 13. Mémoires de l'Acad. des Sciences, 1744.

Morgagni Advers. anat. 11.

J. Hunter's Natural History of the human Teeth, Part I.

Cuvier, in tom. 3. of his Leçons d'Anat. compar. has accurately described the under jaw of quadrupeds.

CHAP. XI.

OF THE CAUSES WHICH DETERMINE THE SIZE AND FORM OF THE SKULL, AND OF THOSE CAUSES WHICH LEAD TO AN ALTERATION OF ITS SHAPE.

THE cavity of the cranium is proportioned to its contents; and hence there is much variety as to the size of the head, and also as to its form, in different subjects. It is neither so broad nor so deep at its fore part, in which the fore part of the brain is lodged, as at its back part, in which the back part of the brain and smaller brain are lodged.

The greatest diameter of the cranium, is from the fore-head to the hind-head, and is equal in the adult to somewhat more than six inches: the greatest transverse diameter is generally between four and five inches and a half; and the greatest perpendicular is from the vertex to the foramen magnum occipitis.

Dr MILLIGAN, in the Notes to his valuable translation of MAJENDIE'S *Physiology*, has made the following remarks on the size of the skull at different periods of life. "The mean greatest length of the skull is $6\frac{5}{12}\frac{9}{0}$, breadth $5\frac{2}{12}\frac{3}{0}$ according to Dr MONRO'S measurement of Adults, Out. I. 351. Hatters add the two diameters together and take their arithmetical mean for the diameter of hats, which surround and measure the external visible circumference of the head. As the number of heads they measure is immense, and they themselves are void of all theory, the following table obtained from an eminent manufacturer, and exhibiting the mean diameters of the "external head" at the different ages, may assist us in comparing the growth of the brain with that of the head.

"*TABLE of Mean Diameters of* HEADS.

"For a Child of	1 year	$5\frac{5}{8}$ inches.
	2 years	$5\frac{7}{8}$
	4 years	$6\frac{1}{8}$
	7 years	$6\frac{5}{8}$ It then varies
	12 years	$6\frac{7}{4}$ little till 12.
	16 to 18	$6\frac{7}{8}$
	Adults	$7\frac{1}{6}$
		Largest $7\frac{3}{4}$ to $8\frac{5}{4}$

"Servants' heads generally small $6\frac{3}{4}$ to $7\frac{1}{4}$; also Negroes heads are small. Womens heads are more roundish than mens."

"From this Table and Dr MONRO's, taken in comparison, it appears, that at seven years the head has attained only the same size as the brain exhibits in adults. The brain, therefore, within the head ought at seven years to have attained its full size."

Dr SOEMMERING, who has devoted the most minute attention to the size of the head in very early life, has observed, "Quo junior embryo, eo majus est volumen capitis ad truncum collati, sive, quod eodem redit, truncus tunc temporis minimus apparet. Omnium ergo maximum est caput illo tempore, quo primum illud conspicere vel distinguere licet. In embryone primo caput truncum magnitudine tantum æquat, in tertio truncus magnitudinem capitis superat. Post mensem primum sensim minus læte caput crescit, adeo ut rationem incrementi trunci propius accedat, quemadmodum in embryone quinquemestri caput ratione trunci non adeo grande videmus. Facies eo minor ad cerebri conceptaculum est, quo junior embryo."

There is no part of the human skeleton which is more variable in its shape, and the proportion of its several parts, than the skull, even amongst the inhabitants of the same nation.

Some of the causes of these very remarkable differences in the skull may be readily explained.

The form of the skull is determined in a certain degree by the soft parts; in proof of which, the internal table of the skull takes the exact impression of the convolutions of the brain and cerebellum, of the glands of Pacchioni, of the ramifications of the arteries of the dura mater; and its external surface displays impressions of the action of the external muscles, as well as traces of the form of the features.

The natural form of the skull has been explained in two different ways by anatomists. According to some authors, the brain serves as a mould on which the skull is formed; but according to others, the skull serves not only to limit the growth of the brain, but also to determine its peculiar form. Both of these opinions are to a certain extent just; but I apprehend the former has less influence upon the form of the head than the latter. Let us consider, *first*, what facts shew that the form of the skull is independent of the brain; and, *secondly*, Let us direct our attention to those facts which prove that the form of the skull is modified by the form of the brain.

The skull is so constructed as to protect the brain in the best possible manner. This is referable to the arched form of the frontal bone, to the arched form of the upper portions of the parietal bones, and the arched form of the occipital bone, to which the internal spines of the frontal and occipital bones so essentially contribute; and also the very singular manner in which the frontal and parietal bones are connected, which cannot be the result of any peculiar form of the brain. How could the brain make the frontal bone rest upon the parietal bone, at the upper part of the head? Or how could internal pressure make the parietal bones take advantage of the arch formed by the frontal bone, at the sides of the head, where the bones are in danger of being beaten inwards by external violence?

There are internal spines connected with the frontal and occipital bones, for the sake of additional security, but no correspondence in the external form of the skull. There is also, for the sake of additional security, a large and prominent

process connected with the occiput behind, with which there is no internal corresponding concavity.

The form of the skull is subservient to the improvement of the senses of vision and smell, and to the protection of the more delicate nerves, on which the senses depends. The skull is flat at the sides, in order that our sight might not be limited to those objects that are immediately before us. The superciliary ridges are so constructed as to protect the eye-balls, and to prevent the sweat of the brow from running into them; and the external angular processes jut outwards to protect the eye-balls. The brain can have no influence whatever on the peculiar form of either of those parts of the frontal bone.

The peculiar form of the bones around the nose, which contributes so much to improve the sense of smell, does not depend upon the brain, nor does it influence the form of the sinuses which communicate with the nose.

There are also in all skulls two prominences in the frontal bone, one in each parietal bone, and one in the upper and largest portion of the occipital bone, at the original centres of ossification of these bones.

The action of the temporal muscle must also be taken into account: in the *Negro* skull, and also in the *Carib* skull, in which it is much thicker and much stronger than in the European, it must have a considerable effect in compressing the sides of the head.

To this catalogue of external causes which materially influence the form of the skull, may be added the effect of the customs of particular nations.

The influence of external pressure is likewise to be taken into account, which is sometimes so great as to counterbalance the internal distention.

The operation of external pressure partially applied, ought also to be taken into account. I do not pretend to dispute, that there is an original difference in the form of the skull. I am also fully persuaded, that much of this variety may fairly be imputed to the different means of compression, which the customs of different nations have introduced: hence the skull

may receive a peculiar, and what may perhaps be called *national* character, from some peculiar artificial method of applying the pressure *.

Hippocrates † goes further, and seems to be of opinion, that an artificial form of the head, the result of the above singular custom practised for several generations, has at length become hereditary, and constitutes the national peculiarity.

Vesalius imputed the round form of the Turk's head to the influence of the pressure of the turban.

The skull of the Carib strongly demonstrates the influence of external pressure.

In the museum bequeathed by my Father to the University, there is an excellent specimen of the skull of a *Carib from St Vincent's*, and I have two casts of skulls of that nation.

In all of these, the forehead is very flat: in one of the casts there is a distinct indentation about the size of a crownpiece, which is more concave than any other part of the forehead, and in the other cast, the depression on the forehead resembles a horse's shoe, the concavity of which looks towards the orbits.

There is a remarkable rising in the skull, immediately beyond the depressed portion. The sides of the skull are very flat, and the temporal fossæ are very large. The base of that portion of the skull formed by the os occipitis is very flat, and the rest of the base is much distorted. The upper jaw is prominent, but not so much so as in the Negro skull, nor is it so broad. The bones of the nose are short, and the

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* Herodotus. † Vid. Adair's Hist. of the American Indians.—Condamine, Mém. de l'Acad. des Sciences de Paris, 1745.

† Hippocrates states his opinon, that the remarkable form of the heads of the *Macrocephali* is the effect of pressure; and observes, "Quum recens infans natus est, caput ejus, adhuc tenerum ac molle existens, quam celerrime constringunt manibus, coaptantesque cogunt in longitudinem augeri; quin et vinculis connectunt, ac aptis instrumentis colligant, quo rotunditas capitis prohibeatur, ac longitudo augeatur." He has added, "Temporis vero progressu, natura quoque tales produxit, *ut non esset necesse consuetudine priore cogere.*"—De Aëre, Aqua, et Locis: Edit: Vanderlinden.

nasal cavity is considerably larger than in any other skull in my possession.

I should suppose this peculiar form of tne forehead to have been occasioned by pressure artificially applied. The skull projects considerably behind, and that part of the occipital bone which is below the great arch is quite flat.

The effects of pressure are still more evident in the casts of the skull of the Caribs. They measure from the most prominent part of the occiput to the root of the nose $7\frac{1}{2}$ inches in the one case, and $7\frac{1}{8}$th in the other. They are also of considerable breadth, and measure between the most prominent portions of the parietal bones 6 inches.

The artificial pressure seems also to have lessened the distance between the upper part of the skull and its base, for in both, the temporal fossæ are distorted; the upper portions of these fossæ is little lower than the line of the summit of the head at the sagittal suture; and the distance between the origin of the zygomatic processes of the temporal bones, and the top of the head, is only $4\frac{1}{2}$ inches in both the casts.

The unnatural breadth of the skull behind, had in my mind compensated for the loss of space occasioned by the unnatural depression of the forehead.

Besides, in the skull, and also in the two casts, there is a distinct transverse ridge, near to the junction of the frontal and parietal bones.

When the casts are examined from behind, there may be observed in each of them a depression in the site of the sagittal suture.

In the skull, as also in the two casts, the orbits are large, somewhat of a circular form, and directed upwards, and nearly an inch intervenes between them. In one of the casts, and also in the skull, the nasal cavity is larger than in any other skull in my possession, a circumstance which may serve to explain the great acuteness of the sense of smell in that tribe of people.

The face is broad: across the cheek bones it measures 5 inches in one of the casts, and $4\frac{1}{2}$ inches in the other, and in the skull $4\frac{5}{8}$.

It has been objected, that the forehead is occasionally low and even flat, when there was no evidence that pressure had been applied, as in countries in which civilization has far advanced.

It has been also stated, that if pressure had been made on the forehead, a counter pressure must have been applied to the back part of the head; hence the skull, instead of being prominent behind, should have resembled a sugar loaf, and should have been much elevated at its vertex.

But all speculation as to this question, in as far as it regards the Caribs, is set aside by the concurrent testimonies of Labat *, Condamine †, Oviedo ‡, and others. These authors have described the time of life, and mode in which, the pressure was applied, to the forehead, which is thus so much flattened, that they can see objects above them without raising the head; and the very bandages with which the pressure had been applied have been sent to Europe ||.

Pressure, even in our day, is employed to alter the form of the skull, according to Messrs Lewis and Clarke §, among the Northern and Southern American Indians.

The skulls received by Dr Mitchell from Colonel T. H. Perkins, are of a most remarkable character, and were brought from the *Columbia River, on the north-west coast of America.* They were compressed, as if by the action of a heavy weight, or strong mechanical power, acting downward

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* Labat, tom. ii. p. 72, has observed,—"Les Caraibes sont tous bien faits et bien proportionnés; les traits du visage assez agréables. Il n'y a que le front qui paroit un peu extraordinaire, parcequ'il est fort plat et comme enfoncé. Ils ne naissent point comme cela, mais ils forcent la tête de l'enfant à prendre cette figure, en mettant sur le front de l'enfant nouveau né une petite planche liée fortement derriere la tête, qu'ils y laissent jusqu' à ce que le front ait pris sa consistence, et qu'il demeure applati, de manière que sans hausser la tête ils voyent presque perpendiculairement au dessus d'eux."—Voyage aux Isles de l'Amerique.

† Mém. de l'Acad. des Scien. 1745.

‡ Hist. gen. de las Indias, 1535.

|| Journal de Phys. Aout 1791, tab 1. & 2.

§ Travels to the source of the Missouri.

and backward from the frontal bone. This pressure must have been begun in early infancy, and continued for the whole time during which the bones were yielding and flexible.

The consequence is, that the os frontis is depressed almost to an angle of eight or ten degrees. The parietal bones are crushed down in a similar manner, and brought as nearly as possible to a level surface. In two of the skulls the coronal and sagittal sutures are much less distinct than common, and in some parts almost obliterated.

The most evident effect of this violence to the cranium is the protrusion of the parietal bones behind the ears, to make room for the squeezed and displaced brain.

This is such as to impart to the head a deformed, monstrous, or rickety appearance.

It is understood, that the mechanical power thus applied to the head, widens or enlarges its base as well as its summit. The individuals who undergo the operation are children of the more considerable and important families.

The lower and plebeian orders are not honoured with the distinction of *flat heads*. Such a skull, of the rounded form, which nature gave it accompanies the others, and makes a striking contrast *.

In short, from what has been stated, the conclusion seems to me legitimate, that the external table of the skull does not correspond in its course with the internal one; it bears the obvious impressions of the actions of the muscles fixed to it, and even, in some skulls, of the transverse wrinkles of the forehead,—of the effects of compression, as in the *Carib* and some of the American Indian skulls,—of external violence, as in the skulls of the natives of New South Wales, and Van Dieman's Land,—of the original centres of ossification of the component bones of the skull, as well as traces of the particular form of the features of the countenance.

But the internal table is an exact mould of the surface of the dura mater of the brain.

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* Vide American Journals.

The form of the external table of the skull may also be changed by disease.

Thus, tumours of different descriptions grow from the softer parts as well as from the skull, which materially alter its form. Thus, I have represented in my Outlines of Anatomy, Plate XII. the skull of a rickety person, which was nearly an inch thick; in that instance the sweep of the internal table does not correspond with that of the external table.

I now proceed to enumerate, those circumstances which demonstrate the influence of the brain upon the form of the skull.

That the cranium owes its shape chiefly to the extension of the contained parts, and the resistence of the external organs, seems proved, or at least rendered probable, as the brain and cerebellum of the fœtus are formed, long before the skull, and it is impressed by the brain.

It may readily be supposed, that the bones of the skull, which in the fœtal state are formed between the pericranium and dura mater, and which are originally in a soft and elastic state, should take on the shape of their contents.

The ossification of the skull goes on but slowly: it is not completed until the child has attained its third or fourth year, and often not until a later period: hence the bones, which are not so hard as in advanced life, more readily receive and retain the impressions of the convolutions, and other projecting parts of the brain, and are so impressed by these, that, by an attentive examination, it is easy to determine what part of the skull has been most acted on.

Thus, upon comparing the top with the base of the skull, the latter is found very unequal in its surface, as it not only resists the extension of the brain, but also supports its weight.

Further, these impressions in the base of the skull become deeper during the progress of life.

As *general pressure* produces so manifest a change upon the form of the skull, that pressure, *partially applied*, may also lead *to the distortion of the skull;* and hence the skull will be expanded in the direction to which the head is inclined.

The brain of a child, by particular posture, presses more on the one part of the skull than the other. If the head be unequally balanced on the spine, it will expand in the direction to which it inclines, and one side of the skull will become considerably more capacious than the other. This may arise from an awkward way of standing, from one leg being longer than the other, from wry neck, or any other cause which keeps the head constantly inclined to one side.

Dr CAMPER has published the case of a young woman, which shews clearly the effect of pressure: his patient carried her head to one side, so that the brain was lodged principally upon the orbit of the lower side; in consequence of which, one eye was lower down in the face than the other, and the forehead assumed a particular appearance.

The influence of the softer parts upon the form of the harder parts, is also obvious from the remarkable alteration in the form of the jaws after the teeth have fallen out. The roof of the mouth, which in the meridian of life was arched, in advanced life, when the teeth have fallen out, becomes flat; the cavity of the mouth is materially lessened, there is not sufficient space for the tongue, and hence it is protruded out of the mouth.

The distance of the chin from the nose becomes shorter by one-sixth part of the length of the head. The pulps of the teeth also determine the form of the teeth; for the pulps before the process of ossification has commenced have precisely the same form as the tooth, and after the body of the tooth has been formed, the pulps are elongated, forming the basis on which the roots of the teeth are formed.

The changes as to the size and form which the skull undergoes, during the different stages of Hydrocephalus chronicus, also afford evidence of the influence of internal distention upon the form of the skull, and also of the effect of posture and pressure.

I have described * two cases, which afford striking examples of the operation of posture and pressure in modifying the

* Vide DUNCAN'S Annals of Medicine for 1803.

form of the head. In the former, from the boy sleeping most frequently on his back, the back part of the head on which he rests had become flat: and as, in the latter case, the child was suckled at one breast only, the pressure of the mother's arm prevented the one side from bulging out so much as the other.

It is obvious, that where the internal pressure is greatly increased, and the bones of the skull give way, this enlargement must be unequal, owing to the unequal resistance of the skull.

As the chief circumstances, upon which this unequal resistance depends, in my opinion, are the progress of ossification, and the connection of the different bones of the head, I shall now proceed to explain the effect of these more fully.

From the imperfect ossification of the bones of the head, when the child is born, it follows, that when the disease originates while the fœtus is *in utero*, the skull must more readily give way, and more readily acquire a large size, than when the disease occurs at a later period of life, and where the bones of the skull are burst assunder, after having been previously united.

The form of the skull of the fœtus is very different from that of the adult: in the former, *the skull projects remarkably at the original centres of ossification of its component pieces*, and hence the upper part of the skull of the fœtus is not so round as that of the adult.

In the adult, those prominences which are very apparent in the fœtus disappear, owing to the gradual growth and alteration of the shape of the brain, which serves as a mould on which the skull is formed; the skull adapting itself to the form of the brain.

But as, in consequence of hydrocephalus, the growth of the brain is checked, or in some measure suspended, the brain does not acquire its usual form; and as the brain is pushed outwards from the accumulation of water within it, the bones of the cranium, though they increase in size, *retain the form they had when the child was born*, and the ossific spiculæ, instead of describing portions of spheres, as they do at a later

period of life, describe only straight lines from their centres of ossification.

Hence the head of a child labouring under hydrocephalus chronicus, notwithstanding its increased bulk, preserves for some time at least the form it had at birth.

Some of the prominences on the head are more apparent than others: those on the fore-head especially are apparent even to the most superficial observer: the others also may be discovered by a careful examination.

These prominences, in cases of hydrocephalus, correspond in situation, as in the fœtus, with the original centres of ossification of the different pieces of the cranium.

The os frontis in the fœtus is composed of two pieces. Two projecting parts are seen in the fore-heads of all children labouring under hydrocephalus chronicus. There is also *a well marked projection on each side of the head*, corresponding with the centres of ossification of the parietal bones.

There is only one projection in the upper and middle part of the os occipitis, which corresponds in situation with the largest piece of the os occipitis of the fœtus.

It also frequently happens, that there is a *marked inequality in the size of the projections on the opposite sides of the head*, which gives the head a distorted appearance; and in some instances, such inequality in the growth of the cranium takes place at the back-part of the head; in others, in the forehead.

In one of the cases which I met with, that part of the head which is opposite to the centre of ossification of the right parietal bone, is more prominent than the same part of the skull on the left side; but the skull on the right side, underneath the prominent portion, is almost flat; whereas the corresponding portion on the left side bulges out, and forms a semi circular line downwards towards the neck.

In another case, *one side of the os frontis is much more prominent than the other*, and to such a degree, that if the profiles of both sides of the head were taken, no one would imagine them to represent different views of the same head: the one resembles the profile of a child whose *head is a little*

larger than usual; whereas the other, from the forehead being very prominent, bears all the characters of the head of a child labouring under hydrocephalus chronicus.

May not the above fact be attributed to a larger quantity of water being effused on one side of the head than on the other? the cause of which has been well explained in the following letter from my late ingenious colleague Dr Rutherford, to my Father: "I have seen," says he, "one of the ventricles much enlarged and full of water, while the other remained of its natural capacity, and contained hardly any water. This appearance I should however impute, not to the obliteration or obstruction of the communication between the lateral ventricles, but to one side of the brain being more affected with disease, more flaccid and tender than the other; in consequence of which, a greater exudation had taken place from the vessels of this part, and the sides of the ventricle had yielded more readily to the pressure of the water, as it was effused."

Such, in general, is the state of the head in the first stage of hydrocephalus chronicus; but it is proper to remark, that cases occur where some parts of the surface of the skull are below the level of others, which is probably owing to the ossification not being completed at those places.

During the progress of the disease, the head exhibits many striking varieties as to form and size. It never preserves its natural form. It acquires an unusual breadth; but especially at those parts *which correspond with the centres* of ossification of the parietal bones, and also *in the forehead.*

The effusion of a watery liquor into the cavities of the brain, which takes place to a greater or less degree in different instances, produces these effects.*

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* The undulation of a fluid within the head, may be distinctly perceived at the sutures, if the watery liquor has been effused between the membranes of the brain; nay, even where it is effused within the ventricles, especially if the quantity of it be large; as in such cases, in consequence of the pressure by distention, a great part of the brain is absorbed, and a communication is formed betwixt the water which is effused between the membranes, and that within the ventricles of the brain.

The former change is owing to the separation of the parietal bones; the latter is the consequence of the separation of the upper part of the pieces composing the os frontis; (for the lower parts of the pieces of that bone, on account of their connections with other bones, which are ossified at an early period of life, cannot recede from each other to any distance); and hence the face, instead of being nearly oviform, somewhat resembles a triangle, of which the brow makes the basis, and the chin the apex.

As the disease advances, *the forehead becomes unusually prominent*, to such a degree, as often to prevent the unfortunate sufferer from seeing objects above the level of his eyes.

During the continuance of the hydrocephalus chronicus, the distance from ear to ear, or the transverse diameter of the head, is increased, and the width of the head is most remarkable between the centres of ossification of the parietal bones. A disunion takes place between the upper portions of the pieces of bone which compose the os frontis, which is the cause of the very remarkable breadth of the upper part of the forehead; and hence the forehead is somewhat of a conical form, the apex of the cone being at the root of the nose, and the base of it at the upper part of the forehead.

From the continuance of the disease, owing to the water contained within the head elevating the *bregma*, and membrane between the parietal bones, the form of the head is still farther changed; *its upper part becoming somewhat of a conical figure.*

During the progress of the ossification, and from the internal distention continuing to exert its influence over the growing osseous fibres of the skull, which, on account of their length and weakness, do not oppose as much resistance to the internal distention as the centres of ossification; the next change is the *bulging out of the bones at the sides of the prominences*, which is the consequence of a very large collection of water within the head, and only occurs when the disease has been of two or three years standing.

The bones bulge out at the sides of the original centres of ossification of the pieces of the skull, which form the most re-

sisting points; and hence, in this stage of the disease, the prominences in the skull corresponding with the original centres of ossification of the pieces of the cranium, are less apparent than in the head of a child who has laboured under hydrocephalus for a few months only.

CHAP. XII.

OF THE DISTINCTIONS IN THE SKULL OF THE MALE AND FEMALE, AND OF THE DISTINCTIONS OF THE SKULLS OF DIFFERENT NATIONS.

SECTION I.

Of the distinctions between the Skull of the Male and Female.

THERE are several marks of distinction between the skulls of the female and the male.

In the female, the skull is lighter, owing to its greater thinness. The cranial part bears a larger proportion to the bones of the face, all of which are smaller and not so much impressed by the muscles as those of the male: it is narrower in front but broader behind. The alveolar processes are not only smaller but more of an elliptical form.

The palatine processes of the superior maxillary bones are more contracted, so that the mouth is smaller.

The teeth of the female are smaller and rounder than those of the male.

The skull of the female, in proportion to the stature of the individual, is in circumference greater, but it is generally not so much elevated at the vertex as that of the male.

The frontal sinuses are not so conspicuous, and when opened are found not to be so large in any of their dimensions.

The superciliary ridges do not form so prominent a feature of the female skull, and, according to some authors, the sagittal suture is more frequently continued down to the root of the nose.

It is a remarkable circumstance that the above distinctions in the conformation of the skull are distinguishable, according to SŒMMERING, in very early life. He has observed, in the text which accompanies his very beautiful engravings of the fœtus, " Embryonis enim masculini caput, ratione corporis reliqui habita, in universum amplius, at minus rotundatum videtur fœminino, occiput præterea plerumque elatum, gibbum quasi prominet, vertex capitis simul paululum complanatus, cervix autem nonnihil sinuata. Embryonis vero fœminini caput, in universum minus amplum, magis rotundatum vero videtur, occiput præterea plerumque vix elatum, vertex simul sphæricus, cervix minus sinuata quam in masculinis. Hinc etiam puellis formosioribus adultis cervix minus sinuata esse solet."

SECTION II.

Of the Distinctions in the Form of the Skull of Different Nations.

Few subjects relating to structure alone can be considered as more deserving of attention, than an investigation into the national peculiarities as to the conformation of the human head, and hence it is not to be wondered that this department of natural history has in all ages attracted much notice.

The science of physiognomy, in whatsoever light it may be regarded, is intimately connected with anatomy. LAVATER considered the knowledge of the conformation of the skull as the basis of this science.

The skull indicates to a certain degree the size and form of the softer parts which cover it, and, on the other hand, the softer parts imprint the harder.

The small head of the Negro, his large and coarse features, his prominent cheeks, flat and wide nose, large mouth, and prominent large teeth, correspond with the peculiar form and size of his skull; while, on the other hand, the larger cra-

nial part of the skull, the more delicate bones of the Circassian face, the straight and elevated nose, small mouth, thin lips, and smaller teeth, which are fixed perpendicularly in the head, accord with the more delicate conformation of the bones of the face.

Though the distinctions in the form of the skull had attracted the attention of the older authors upon anatomy and history, yet they took too general a view of the subject; they did not devote that minute attention which is necessary to the full exposition of all the national peculiarities.

Within the last century, the extensive regions of *Asia*, *Africa*, *America*, *Australasia*, and the *Islands of the Pacific Ocean*, have been explored; many new facts, as to the form of the head, and the customs of the people, of different nations, have been brought to light, and the errors which the *Jesuits* and *Buccaneers* had propagated respecting the savage state, have been exposed and corrected.

The exploring untraversed oceans (says Mr KEATE), in spite of every danger that could menace,—the discovering multitudes of islands and of people whose existence was not known before,—and the fame of fixing the geography of the southern world, were the noble fruits of this bold and hazardous enterprise, which will remain, to succeeding ages, a monument of the zeal and patronage of GEORGE THE THIRD. If Mr KEATE had lived to this day, he might have added, after the southern, also a northern world *.

The subsequent pages contain a sketch only of the differences in the conformation of the head of different nations. Any attempt to explain the cause or causes of these varieties of conformation, (excepting such as are purely mechanical), must have led to a wide digression, totally foreign to the nature and limits of this elementary book, which precludes a complete and systematic view of the natural history of the form of the human head.

Modern authors have not only more accurately and fully described the differences in the form of the head of the

* Vide KEATE's Pelew Islands, Introduction, p. 11.

various inhabitants of the globe, but have devised means for more distinctly defining these. Much praise is due to DAUBENTON, ALBERT DURER, CAMPER, and BLUMENBACH, and more especially to the latter, who has formed by far the most extensive collection of skulls that exists, and who has enriched, to a great extent, this department of natural history, by many novel and interesting facts.

Of the method proposed by DAUBENTON, mention has been already made *: it indicates some of the distinctions between man and the inferior animals, but it is not a complete index to the distinctions between the different races of men.

The method of CAMPER has been already explained †, together with the objections to which it is liable. BLUMENBACH arranges the skulls in a row, and examines them from behind. Thus he sees the breadth and narrowness of the forehead, its arched or flat form, and the direction of the jaws and teeth, and this he has called his *Norma Verticalis.* But such a view is partial, and does not present to us many important differences in the shape of the bones of the face, especially the very different form of the orbits, and many of the peculiarities of the upper and under jaw bones. He seems to have been fully aware of the imperfection of his method, and more especially after his collection of skulls had become more extensive.

CUVIER has proposed a different method of measuring the size of the skull, and its proportions to the bones of the face. "We may (he has observed) discover more important relations in considering the cranium and the face, *under the vertical and longitudinal section* of the head ‡."

With respect to their relative proportions, the cranium in this section occupies an area sometimes greater, sometimes less, and sometimes nearly equal to that of the face. In the European, *the area of the section of the cranium is almost four times greater than that of the face,* the lower jaw not included.

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* Vide p. 121. † *Supra*, p. 159.

‡ Vide CUVIER, translated by ROSS, p. 10.

In the Negro the cranium remains the same, but *the area of the section of the face is increased about one-fifth.*

My friend Dr Leach invented a craniometer, which is well adapted for ascertaining some of the differences in the skull; and to shew its varied application, he was so polite as to construct for me the annexed Table.

TABLE I.

MEASUREMENT OF SKULLS IN DR MONRO'S MUSEUM.

Kind of Skull.	Superior basi-facial angle.	Inferior basi-facial angle.	Inio-glabellar diameter.		Anterior transverse diameter.		Posterior transverse diameter.		Distance of the foramen magnum from the Inion.		Corono-basilar-diameter.	
	Degrees.	Degrees.	Inch.	10ths.	Inch.	10ths.	Inch.	10ths.	Inch.	10ths.	Inch.	10ths.
A European female, -	73½	50	7	8	3	8	5	3	2	3½	4	2
A European female, -	73½	0	6	0	4	0	5	5	2	3	4	5¼
A European female, -	74	51	6	9	4	1	5	2	2	7	5	5
Russian male, -	74	50½	7	0	4	4½	6	0	2	6	5	5
Negro male, -	72½	47	7	2	3	7	5	3	2	2	5	7
Negro male, -	69	41	7	2	4	2	5	7	2	4	5	2
Lascar male, -	72½	0	6	5	3	4	5	8	2	0	5	8½
Carib, (male?) -	61	0	6	0	3	7	5	2	2	3	5	4
New Hollander (male?)	0	0	7	3	3	9	5	1	2	8½	5	6
Esquimaux, - -	0	0	7	0	3	9	5	3	2	8	5	6
Hindoo, - -	81	62	6	8	3	3	4	5	2	4	4	4
A curious skull in the College Museum, supposed to be that of a Mummy, as it is filled with pitch.	0	0	8	1½	4	1½	4	5	0	0	0	0
Hottentot, -	0	0	7	9	4	0½	0	0	2	7	6	9

I have put in a note Dr Leach's explanation of the terms he has employed *.

But all craniometers made of wood or metal are objectionable; such unyielding materials not adapting themselves to the inequalities of the surface of the skull.

In illustration of what I have affirmed, I shall take the os frontis as an example.

Thus the frontal *sinuses* scarcely exist at the period of birth, but in the adult are generally conspicuous, and in the male sometimes very large: the common craniometer, when applied to the os frontis, is laid along the most prominent part of this bone; it therefore gives the angle which is formed by the projecting os frontis opposite to the frontal sinus, but not the angle formed by the os frontis above the frontal sinuses; so that the os frontis has been sometimes described as being very prominent, while in truth it was the reverse, the projection being caused by the large

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* *The superior basi-facial angle*, is measured by drawing two lines, the first parallel with the palatine process of the superior maxillary bone and foramen magnum occipitale, the second resting on the middle of the antinial portion of the glabella, and continued over the bones of the nose until it meets the first line; and the angle of their junction is termed the *superior basi-facial angle*. I may observe, that this, and all the other measurements here stated, were first proposed by Dr Barclay in his "New Anatomical Nomenclature," a work now in general use amongst zoologists. In the two first measurements we have ventured to alter the facial line, which Dr Barclay causes to rest on the suture formed by the nasal bones and nasal process of the superior maxilla, whereas ours is drawn along the mesial plane. Figures of two instruments for measuring the skull are given in Dr Brewster's New Edinburgh Encyclopædia, under the article *Craniometry*.

The inferior basi-facial angle differs from the above in being the basilar line resting on the foramen magnum and chin in the mesial plane.

The Inio-glabellar diameter is the distance between the back part of the head, or Inion, and the glabella, or forehead.

The anterior transverse diameter is measured across the narrowest part of the forehead, which is always the antinial portion in man.

The posterior transverse diameter, across the skull, is measured from the centres of ossification of the parietal bones.

The Corono-basilar diameters are ascertained by causing one line to rest on the foramen magnum and palate, another on the coronal aspect of the cranium, and measuring their distance from each other.

frontal sinuses, and not by the whole os frontis. I have seen several persons whose foreheads were remarkably prominent at the frontal sinuses, but in which the upper part of the os frontis retreated nearly as much as in the greatest number of African skulls.

The above observation applies also to the skulls of quadrupeds; for in these the frontal sinuses are much more capacious and extensive than in the human skull: in some, as the elephant and owl, they extend over the whole skull.

A better craniometer may be made of four pieces of wood or brass, divided into inches, and properly subdivided, and one of which may be moved either in a horizontal or in a perpendicular direction: and for the sake of still greater accuracy, a Nonius or Vernier is added to one of the sides. Holes are perforated at each inch or half-inch of the sides of the instrument, for the purpose of affixing silk threads, which are stretched from one side of the instrument to the other, by which a number of small squares are formed. By placing a skull behind these squares the form of the skull is seen with accuracy, and may be transferred to a piece of paper divided in a similar way. It may be copied, or reduced, with mathematical accuracy, and every deviation from the most common shape, may be traced and represented on paper, by one who has attained but little proficiency as a draughtsman.

The following remarks on the more marked differences in the form of the skulls of different nations have been taken chiefly from my own collection of skulls, which, through the kind offices of many good friends, is now considerable. I have also derived some useful observations from the careful examination of skulls in the *Museum of Natural History of the University*, and also in that of the *Phrenological Society*, to which I have had free access through the liberality of Mr Combe.

In order to shorten the labour of the reader, and, at the same time, to place in a prominent point of view the distinctive characters of the crania of different nations, I have collected into a table the measurements of skulls of different nations, and have selected such as have not been fully described by former authors.

TABLE II.

Number.	Nations.	Measurement taken from the root of the Nose, over the middle of the Skull to the posterior edge of the Foramen Magnum Ossis Occipitis.	Measurement taken across the Skull, from the back part of the Meatus Auditorius Externus of one side to the similar spot on the opposite side.	Circumference of the Skull, taken on a level with the Superciliary Arches.	Distance from the fore edge of the Os Occipitis, to the most prominent part of the Upper Jaw Bone.	Length of the Skull from the root of the Nose to the most prominent part of the Os Occipitis, by Calliper compasses.	Greatest breadth of the Skull, measured by Calliper compasses.	Breadth of the Cheek bone, by the same instrument.	Breadth of the Alveolar Process, by do.	Distance between the organs of the Coronal Suture, on the opposite sides of the Skull.
1	Circassian girl *, 10 years old,	$12\frac{6}{10}$	$11\frac{5}{10}$	$17\frac{1}{2}$	$3\frac{2}{10}$	$6\frac{2}{10}$	$4\frac{9}{10}$	$3\frac{6}{01}$	$1\frac{9}{10}$	$3\frac{4}{10}$
2	English Female, adult,	14	$11\frac{1}{2}$	19	$3\frac{2}{10}$	$6\frac{8}{10}$	$5\frac{3}{10}$	$2\frac{1}{2}$	$2\frac{2}{10}$	$3\frac{9}{10}$
3	King Robert the Bruce,		13	$22\frac{2}{8}$		$7\frac{3}{4}$	$5\frac{1}{2}$	5	3	$3\frac{7}{8}$
4	Hindoo,	$13\frac{5}{8}$	$11\frac{5}{8}$	$18\frac{1}{2}$						
5	Hindoo,	14	12	19	$3\frac{1}{2}$	7	$4\frac{3}{4}$	4	$2\frac{2}{10}$	4
6	Gentoo, male,	$13\frac{4}{10}$	$12\frac{3}{10}$	$19\frac{4}{10}$	4	$6\frac{7}{10}$	$5\frac{1}{10}$	$4\frac{2}{10}$	$2\frac{4}{10}$	4
7	Gentoo, female,	13	$12\frac{5}{10}$	18	$3\frac{4}{10}$	$6\frac{2}{10}$	$5\frac{2}{10}$	$3\frac{8}{10}$	$2\frac{5}{10}$	$3\frac{8}{10}$
8	Negress,	$15\frac{1}{10}$	$12\frac{3}{10}$	$19\frac{6}{10}$	$3\frac{8}{10}$	7	$5\frac{2}{10}$	$3\frac{9}{10}$	$2\frac{3}{10}$	$3\frac{7}{10}$
9	African Negro,	$14\frac{6}{10}$	13	$20\frac{7}{10}$	$4\frac{3}{10}$	$7\frac{2}{10}$	$5\frac{7}{10}$	$4\frac{6}{10}$	$2\frac{1}{2}$	$4\frac{6}{10}$
10	African Negro,	15	$12\frac{7}{10}$	21	$4\frac{5}{10}$	$7\frac{1}{2}$	$5\frac{6}{10}$	$4\frac{7}{10}$	$2\frac{4}{10}$	$4\frac{1}{2}$

* A Skull, brought from the banks of the River Hoogly, in the possession of the Phrenological Society, is very similar in point of form and size, to that of the Circassian.

TABLE II.—*continued.*

Number.	Nations.	Measurement taken from the root of the Nose, over the middle of the Skull to the posterior edge of the Foramen Magnum Ossis Occipitis.	Measurement taken across the Skull, from the back part of the Meatus Auditorius Externus of one side to the similar spot on the opposite side.	Circumference of the Skull, taken on a level with the Superciliary Arches.	Distance from the fore edge of the Os Occipitis, to the most prominent part of the Upper Jaw Bone.	Length of the Skull from the root of the Nose to the most prominent part of the Os Occipitis, by Calliper Compasses.	Greatest breadth of the Skull, measured by Calliper Compasses.	Breadth of the Cheek bone, by the same instrument.	Breadth of the Alveolar Process, by do.	Distance between the organs of the Coronal Suture, on the opposite side of the Skull.
11	Kaffre, sent by Sir J. M'Grigor,	15	13	$21\frac{1}{8}$	$4\frac{1}{2}$					
12	Eskimaux, young,	$13\frac{9}{10}$	$11\frac{1}{2}$	19	$3\frac{4}{10}$	$6\frac{7}{10}$	$5\frac{3}{10}$			$4\frac{5}{10}$
13	Eskimaux, Lat. 66° Long. 83°	$15\frac{1}{2}$	$12\frac{8}{10}$	$20\frac{8}{10}$	$4\frac{2}{10}$	$7\frac{6}{10}$	$5\frac{4}{10}$	5	$2\frac{7}{10}$	$4\frac{1}{2}$
14	Eskimaux, Lat. 69° Long. 83°	15	$13\frac{2}{10}$	21	$4\frac{2}{10}$	$7\frac{3}{10}$	$5\frac{7}{10}$	$4\frac{9}{10}$	$2\frac{4}{10}$	$4\frac{1}{2}$
15	Kapitapol, a Candian Chief,	13	$12\frac{1}{2}$	$19\frac{5}{4}$	$4\frac{2}{10}$	$7\frac{2}{10}$	$5\frac{2}{10}$	$4\frac{1}{2}$	$2\frac{1}{2}$	$4\frac{1}{2}$
16	Austral-asian,	15	$12\frac{3}{8}$	20	$4\frac{2}{10}$	$7\frac{2}{10}$	$5\frac{7}{10}$	$4\frac{7}{10}$	$2\frac{7}{10}$	$4\frac{1}{2}$
17	Austral-asian,	$14\frac{6}{8}$	$12\frac{1}{2}$	21	4	$7\frac{2}{10}$	$5\frac{3}{10}$	5	3	$4\frac{3}{4}$
18	Native of Van Dieman's L.,	$11\frac{3}{8}$	$11\frac{3}{8}$	19	4					
19	Native of Van Dieman's L.,	$14\frac{1}{2}$	$12\frac{2}{10}$	$20\frac{3}{10}$	$3\frac{8}{10}$	$6\frac{8}{10}$	$5\frac{3}{10}$	$4\frac{3}{10}$	$2\frac{1}{2}$	$4\frac{1}{10}$

In describing the different skulls, I have followed the arrangement of BLUMENBACH, though it may be said to be arbitrary and imperfect, as it is upon the whole the best classification which has been yet published.

The 1st great class comprehends all the inhabitants of the world that were known to the ancients, excepting the Laplanders.

Of this great class BLUMENBACH supposes the *Caucassian Family* to have been the original stock.

I have taken my characters of this class from the skull of a Circassian girl, of ten or twelve years of age, which is of singular beauty in its form and proportions, and which corresponds very nearly to the Georgian skull represented by BLUMENBACH.

The contour of the whole skull is elegant. The cranial part bears a large proportion to the bones of the face; the forehead is large and prominent, and the facial line is straight; the cheek bones are rounded; the alveolar arch narrow and not prominent. The zygomatic arches are slender, but not much elevated. The orbits are large, and less angular than in other skulls. The alveolar arch is elliptical, but narrow *.

The *Greeks* are also included in this class. The cranial part of the skull is very large in proportion to the face; and the facial line is straight.

BLUMENBACH has stated, that he possesses an ancient Greek skull, which was procured in Magna Grecia, in which the cranial part of the skull bears as large a proportion to the bones of the face, as in any of the celebrated busts of antiquity †.

Even at this day, the cranial part of the Greek skull is large, in proportion to the bones of the face.

As a specimen of a Scotch skull, I shall describe that of KING ROBERT THE BRUCE, which I assisted in removing

* For the measures see No. 1. of Table II.

† My friend Mr LISTER told me he had seen this remarkable skull.

from the vault at Dunfermline. The skull was of a reddish-brown colour, and very irregular as to its surface. When viewed in profile, the prominences of the frontal sinuses are very conspicuous, above which, the forehead inclines backwards as far as the junction of the frontal and parietal bones. Over the sagittal suture, there is a distinct ridge in the skull, which is slightly arched; and, towards the back part of that suture, the skull slopes suddenly downwards and backwards, in an oblique direction.

The occipital bone is remarkably convex outwardly, and strongly marked. The temporal fossæ are deep, and much impressed by the fasciculi of the temporal muscles. The centres of ossification of the parietal bones are prominent. The bones of the face are large, and deeply impressed by the muscles. The orbits are surrounded by thick bone. The zygomatic arches were broad and also high; so that there is every reason to suppose the temporal muscles had been large and strong. The impressions made by the masseter muscles on the under jaw, were unusually deep. The breadth from one cheek-bone to the other is equal to five inches. The distance from the most prominent part of the occiput to the meatus auditorius externus, is about one inch greater than the distance from the meatus auditorius externus to the most prominent part of the upper jaw-bone. The under jaw is strong and of a square form; and, when viewed in profile, there is a distinct prominence of the chin. A line drawn downwards from the frontal sinuses along the bones of the face to the alveolar processes of the under jaw-bone is nearly vertical. The angle which the ascending processes of the under-jaw forms with the body of that bone, is nearly a right angle.

The skulls of the Germans, Swedes, Russians, and Italians*, are not unlike, according to Sœmmering.

* Mr Penny permitted me to copy a skull from a picture by Leonardo da Vinci, which is almost globular. Leonardo himself is represented as having a round head in the print by Bartolozzi, which is taken from a drawing by Leonardo.

The Turkish skull is very round, which has been imputed by VESALIUS to the early use of the turban.

SŒMMERING however has informed us, that he had seen at Vienna several skulls of Turks, which were of a cuboid form.

In my museum there are three or four skulls of Frenchmen, which are nearly similar in form: they are shorter than those of the natives of Britain. But, in the Museum of Natural History, the sixty skulls sent from the catacombs of Paris, are widely different in size and form. Indeed they were selected on account of their differences in form, and as calculated to illustrate the theory of GALL and SPURZHEIM.

The skull of a Norwegian in my collection is very singular in form; the bones of the face are very large, and not unlike those of some Negroes. In the Museum of Natural History, there are six skulls of Hindoos; in that of the Phrenological Society there are twelve skulls of the same nation; I possess two Hindoo skulls, and two Gentoo skulls *. The bony part of the skull is generally white, not at all greasy, and the skull is thin and light. The most striking character of all these skulls is their small size; and they are well proportioned in their several parts. The bones of the face are not much impressed by the muscles, small, and finely formed; the orbits and nose are not surrounded by those thick edges which we observe in the Negro skull, and in that from Australasia and Van Dieman's Land. The forehead is proportionally smaller to the hinder part of the skull than in the European. The temporal fossæ are small, and the mark of the origin of the aponeurosis of these muscles is low down upon the head.

The bones of the face are very small and narrow, excepting the bones of the nose. The squamous parts of the temporal bone are small, but the mastoid processes of the same bones are rather disproportionally large. The orbits are larger than in the European skull, but the cavity of the nose is smaller. The alveolar processes of the upper jaw are very small and narrow. The facial line is nearly straight †.

* For the two last I am indebted to Sir A. HALLIDAY.

† Vide measurements in Table II. Nos. 5, 6, 7, 8.

The above description also applies to the skull of the *Lascar*, excepting as to thickness of its component bones, and as to the facial line, which is not so perpendicular as in the skull of the Hindoo.

In this first class the Egyptians are also included. Much difference of opinion has prevailed, and still prevails, as to the features of the ancient inhabitants of Egypt. According to some authors, they resembled the African Negro, but according to others, the Hindoos.

I have had occasion to see the skulls of five mummies that were brought from Egypt; and have in my possession 2 casts of the skulls of mummies. Two of these skulls resemble that of the African Negro, but all the others are similar to the Hindoo head in size and conformation.

Colonel STRATTON presented to the Museum of Natural History, a mummy, the head of which is in form like the Hindoo; and, in the same museum, there is the cranial part of a skull filled with pitch, which is of a very peculiar form.

It is narrower than common between the external angular processes of the frontal bones, measuring only $3\frac{3}{4}$ inches: the transverse diameter behind, between the junctions of the squamous and lambdoidal sutures on the opposite sides of the skull, measures only $4\frac{1}{4}$ inches; whereas most skulls, at the same place, measure 6 inches or nearly so: the distance from before to behind is, by the callipers, $8\frac{3}{4}$ inches; and the upper part of the skull *forms an arch*, of which the middle of the os frontis constitutes one extremity, and the most prominent part of the os occipitis the other. From the most prominent or highest part of the arch, near the middle of the sagittal suture, to the fore-part of the foramen magnum ossis occipitis, the distance was $5\frac{5}{8}$ inches, being little more than $\frac{1}{8}$th of an inch greater than in most skulls: hence it appears that the pressure applied to the sides of this skull, had added very little to its depth.

According to BLUMENBACH, Egypt, in former times, was peopled by different races of men; for the skulls of some mummies resembled the Hindoos, others the African Negro, and a third set, the inhabitants of the States of Barbary.

But the old Egyptian sculpture represents all the Egyptians as alike; for, though the sculpture is rude, it conveys a distinct idea of the form of the head and features. I have been led to this opinion, from having lately examined many specimens which that distinguished artist Mr JOHN WATSON shewed me.

The form of the head is similar to that of the Hindoo; the eyes are large, and distant from each other; the eye-lids run up to the temples; the ears are placed high on the head; the mouth is very small; the lips thin; the chin is pointed, and with a dimple on it.

DENON, whose authority in all matters connected with the fine arts stands very high, in his Account of Egypt, has given representations of the heads of mummies, which resemble the finest formed heads of Europe. He has distinctly stated that, in point of form, they are equal to the heads of the celebrated sybils of MICHAEL ANGELO; and CUVIER *, who has had occasion to examine 50 mummies, has published a similar report on the form of the Egyptian head.

Of the Second or Ethiopian Class.

This class includes all the Africans which are not comprehended under the first class. The form of the skull in all of these is somewhat similar to that of the Negro. The bone is very white, of a compact texture, like to ivory, and heavy; and the tables of the skull are thicker than those of European skulls.

The distinctive characters of the Negro skull, are the small size of the cranial part of the bone, in its longitudinal and transverse direction; the retreating forehead, which is also narrow; the flatness of the sides of the head; the large size of the temporal fossæ; and the large size of the temporal ridges of the frontal bone, which are sometimes serrated. The parietal bones are smaller, and the impressions made by the temporal muscles are nearer to each other, than in the European.

* See his Account of the Hottentot Venus, Annal. du Mus. tom. iii.

The occipital bone is flatter. The temporal bones are less, and the squamous sutures are not so much arched. Other characters consist in the great size, thickness and prominence of the bones of the face, which seem to have been impressed by large muscles; the prominence of the alveolar processes, and consequent obliquity of the facial line; the oblique direction of the large incisor teeth; the great breadth and height of the zygomatic processes, indicating the large size of the temporal muscle; the retreating chin, as in the monkey tribe; the great size of the cavity of the nose; and the foramen magnum ossis occipitis, being larger and placed further back than in the European skull *.

The African is still farther marked by greater size and thickness of the under jaw-bone, and the greater size and breadth of the teeth, which are more solid and hard, which is, perhaps, the cause why the Negro is not so liable as the European to caries of the teeth. The facial angle is between 60° and 70°.

In short, the seat of the intellectual organs is much smaller in the Negro than in the European skull; but that of the organs of smell and tasting is much more capacious. All travellers agree as to the inferiority of the mental powers of the Negro. According to Mungo Park, an intelligent black man, who had witnessed the knowledge and skill of some Europeans, exclaimed, "Black men are nothing."

My friend Dr Knox, who resided for some years in *Southern Africa*, has been so polite as to draw out for me the following very interesting account of the *Kaffres*, *Bosjesmans*, and *Hottentots*.

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* Vide particular measurements in Table II.

ETHIOPIAN VARIETY.

Negro *	*Kaffre* †, including Temboo, Briqua, Boschuana, Red Kaffres, &c. &c.
Colour generally very dark.	Of a brown colour, or as it were *bronzed*; some perfectly black.
Hair black; and as it is usually called *woolly*.	Hair black, crisp and woolly, and scattered in small tufts over the skull.
Head narrow, compressed on the sides.	Cranium narrow, elongated, resembling in outline the female European.
Forehead arched.	Forehead differing but little from the Negro; *i. e.* rather retreating, narrow, and not high.
Malar bones prominent. Eyes full.	As in the Negro.
Nose thick, and little distinct from the lips.	In the greater number nearly as in the Negro; some have less of the Ethiopian physiognomy.
Upper-jaw powerful and elongated.	Nearly as in the Negro.
The inferior incisors projecting obliquely.	Scarcely the case in the Kaffre.
Excessive fulness of the lips.	As in the Negro.
Retreating chin.	Not so much so as in the Negro.
Many bandy-legged; a certain apparent difficulty in maintaining an upright position; the knees bend forwards, and the heel has a constant tendency to quit the ground. The gastrocnemii muscles are placed too near the ham.	Never the case in the Kaffre. His lower extremities are finely proportioned, and frequently of Herculean strength; the upper extremities weak and disproportioned.

Remarks.—The cranium of the Kaffre is inferior in most of its measurements to the European. The temporal bones are flat and compressed, and the *squamous suture* often straight, instead of being semicircular, as in the European. It results from this anatomical inquiry, that the Kaffre is closely allied to the Negro, aad that he may be called the *Negro* of the *Mountains*; there is no admixture of Arab blood in the race.

* The description chiefly taken from Blumenbach, but compared with several Negro Crania in the possession of Dr Monro.

† The description taken from three Kaffre Crania, selected from those killed in the Zuurveld.

MONGOL VARIETY.

True Mongol inhabiting the deserts of Central Asia *.	African Boschman, including the numerous Hottentot tribes, such as Namaguas, &c. &c †.
Colour yellow, or of an olive tinge.	Colour light-yellow or olive; it is difficult to describe; it varies in intensity amongst the Hottentots, but is pretty uniform amongst true Boschmen.
Hair black, coarse, straight, and thin.	Hair black, generally very short, though sometimes growing to a considerable length, and is scattered over the scalp in detached tufts, as in the Kaffre.
Head of a square form.	General outline of the head much resembles the Mongol; it is broad and square.
Face broad, flat, depressed; the features as it were confluent.	Face has a strong resemblance to the true Mongol; the lips are full.
Forehead smooth and flat.	As in the Mongol.
Nose small and flat.	As in the Mongol.
Aperture of the eye-lids small and linear.	As in the Mongol: the angle at the internal canthus is quite rounded away.
Chin somewhat projecting.	Chin very small and pointed, but not in any way projecting.

General Remarks—In the Bosjesman, there is the finest symmetry of the whole frame; stature remarkably diminutive. The peculiarities in the females, and the uncommon powers of vision of the race, are lost, by a single cross with any other breed or race.

The cranium is finely formed; the nasal processes of the superior maxillary bones large and broad; these give to the Mongol and Boschman the appearance of breadth at the root of the nose. The foramina for the transmission of the hypoglossal nerves, seem uniformly larger in the black than in the white race of mankind, which would indicate the existence of a proportionally large nerve. The cranium of the Boschman, viewed vertically, is nearly equal to the well formed Eu-

* The description taken from BLUMENBACH.

† The description taken chiefly from a Hottentot cranium in the possession of Dr MONRO; and partly from a cast of the Hottentot Venus, in the Museum of the University.

ropean head. The parietal bones bulge out very much, and the cranium is at this point broadest. It agrees with the Mongol, in having the occipital foramina larger than in the other races. The floor of the orbit does not encroach so much on the cavity as in the Mongol; this affects the physiognomy, in so far as regards the direction of the eyes.

TABULAR VIEW of various Measurements of CRANIA, in the Museum of Dr MONRO.

TABLE III.

	Hottentot.	Cranium supposed to be from New Holland.	New Hollander.	Cranium supposed to be Malaic.	European Female.	Hottentot Venus, (from a cast).	Male Kaffre.	Male European.	Negress.	Turk.	Carib.
Length of the face from the root of the nose to the edge of the alveolar process,	Inches 2.3	In. 3	In. 2.5	In. 3	In. 2.8	In. 2.7	In. 2.8	In. 2.9	In. 2.6	In.	In.
From the anterior edge of the foramen occipitale, to the incisive teeth of the upper-jaw,	3.7	3.7	4	3.7	3.7		4.1	3.3	4	3.5	3.5
Breadth at the temples,	3.6	3.8	3.8	4.1		3.5				3.5	3.4
Whole circumference,	19.7			20.1	19.7	19.8	21	20.7	19.6	19.6	18.3
Greatest breadth,	5.2	5.4	5.7	5.8		5.3			5.1	5.1	5.4
Foramen occipitale,	1.3 by 1.5	1.5 by 1.1		1.3 by 1.5					1.3 by 1.1		
Length over the vertex, from the root of the ossa nasi to the posterior edge of the occipital foramen,	14.1	21.1	21	14.5	14.3	13.5	14.6	14.9	14.9		
From one of the mastoid processes to the other, over the vertex,	13	21	21	15.6	14	12.7	14.2	14.7	14.5		

Of the Third or Mongolian Class.

This class includes the *Mongols*, *Calmucks*, *Burats*, the *Chinese*, *Japanese*, the inhabitants of *Thibet*, *Cochin China*, *Ava*, and the various tribes of the *Eskimaux*. PALLAS has given an excellent account of the Mongols and Calmucks,* and of the inhabitants of Siberia.

The head is of a square form, the forehead rather low, the bones of the face are large and broad, especially the cheek bones, the nose is broad at its root, but small and flat, and the chin prominent; the cheeks are round and prominent, lips thick and large, the ears are large; eyes black and placed obliquely, depressed towards the nose, and the internal angle of the eye is rounded.

There is considerable variety as to the form of head of this great class; for instance, the skull of the *Burat* child represented by BLUMENBACH is globular, the bones of the face are broad, and seem as if they had been flattened, and the orbits are large.

Many of the characters of the *Eskimaux*, correspond with the Mongolian class; and, therefore, I shall now describe that remarkable tribe, that are so widely diffused over the northern coast of America.

My description of the Eskimaux skull has been derived from six specimens in my own museum, for three of which I am indebted to Mr EDWARDS, who accompanied Captain LYON, and for one to Mr FISHER, who accompanied Captain PARRY.

These skulls were found at different places; two at Repulse Bay, one at Winter Island, Lat. 66., Long. 83.; and another at Iglulick, Lat. 69., Long. 83. All these skulls are lighter than the Negro skull. The two found at Repulse Bay differ from all the others; they more nearly resemble the European skull, and indeed, one of these more nearly

* See a good figure of the Skull of a Calmuck in SANDIFORT's Mus. Acad. Lugd. Batav., and also by FISHER.

resembles that of the Circassian girl, than any other skull I have seen. The cranial part is very large in proportion to the bones of the face; the bones of the face are not remarkably prominent, and the cheek-bones very much resemble those of some of our country.

The skull found at Winter Island, and an Eskimaux skull in the Museum of Natural History, are very similar to each other. When viewed in front, the size of the cheek-bones is very remarkable, so that the distance across the cheek bones is equal to nearly 5 inches; but the superior maxillary bones are neither very large nor prominent. The forehead gradually becomes narrower, and, when viewed in front, it resembles a triangle, the basis of which is over the orbits. The parietal bones also become narrower gradually as they approach the sagittal suture.

The temporal muscles take their rise very high on the parietal bones, and remarkably so in one of the specimens; hence at the top of the head, the distance between the origins of the opposite temporal muscles is equal to $2\frac{3}{4}$ inches.

The squamous suture is not arched as in the European, but is much flatter.

The orbits are large, but the nasal cavity is rather small. The teeth are generally large, but not long: in some instances, those of the under jaw are smaller than in the European, and are not fixed into the skull like those of the Negro; whereas in one of the skulls found near to *Repulse Bay*, the teeth are small and much worn down. The skull obtained at *Iglulick*, is a sort of medium between those found near to *Repulse Bay* and *Winter Island*. It is like to that of the Mongol class. The cranial part is large in proportion to the bones of the face; forehead narrow, and rather flat; but the skull is broad between the parietal and temporal bones, and rather flat at the lower part of the occipital bone. The superciliary ridges are prominent, and overhang the orbits more than usual; the bones of the nose are broad at their connection with the frontal bone; the cheek-bones are broad; zygomatic arches high; nasal cavity large; and, in this individual, the

foramen magnum ossis occipitis was unusually small, and the distance between the foreparts of the condyloid processes is less than usual. The forehead is large, and is not arched at its summit. The orbits are larger than in the European skull; the nasal cavity is rather narrower; the superior maxillary bones over the alveolar processes are remarkably concave; and, therefore, the antra maxillaria must have been smaller than common. The teeth in this specimen are larger than in any of the other Eskimaux skulls.

When these skulls are examined in profile, they appear very full behind, and especially that from *Iglulick*; and there is an evident depression on each side of the sagittal suture.

The centres of ossification of the parietal bones, however, are prominent, and the distance between these is equal to $5\frac{1}{2}$ inches. The temporal fossæ are not very conspicuous.

The zygomatic arch is rather higher than in the European skull, but not so much so as in the Negro. The facial line inclines obliquely forwards in that found at Iglulick, and in the skull in the museum of Natural History, but in all the others it deviates but little from a vertical line.

In two of the skulls given to me by Mr Edwards, there are additional sutures, passing transversely across the occipital bone, but not at the same place; and the occipital bone in the skull from Winter Island is very narrow.

This skull is by far the narrowest of the specimens, measuring only between the original centres of ossification of the parietal bones 5 inches; but the distance between the root of the nose, and the most prominent part of the os occipitis, is equal to $7\frac{1}{2}$ inches.

After having examined these skulls, I begged the favour of my friend and pupil Mr Edwards, to draw out a short account of the Eskimaux, with which request he most politely complied.

"The Eskimaux of Melville Peninsula, bear a strong general resemblance to their kindred tribes, who inhabit the shores of Hudson's and Davis' Straits. The diversity of features among the former was however much

more striking; and instances were not unfrequent of finely formed oval faces, with aquiline and Roman noses, whose owners had considerable pretensions to beauty, even in the European acceptation of the term. The general character of the tribe consists of a broad round face, with a small arched forehead, sloping and contracting towards the vertex; the cheek-bone projecting laterally, and rounded. Nose small and depressed; the mouth large, lips thick, chin large, the teeth well set, close, and beautiful in the young; but, being destitute of mechanical instruments, they are forced by necessity, in most of the operations and arts, to substitute their teeth, which are gradually worn down; and, in the course of a few years, are reduced almost to the level of the gums. The eyes are small, irides black or blackish brown, the aperture of the lids narrow, and slightly inclined to the nose. There is a peculiarity existing in the eye-lids, more or less observable in the majority, that I do not recollect noticing among the other tribes of Eskimaux, although it may exist. It consists in a duplication of the adjacent loose skin of the nose and palpebræ being tightly drawn over the internal angle of the eye, and completely concealing about a fourth part of the natural aperture, producing the appearances of an additional palpebra of a crescentic figure. The internal cavity, therefore, instead of being angular, is a very obtuse curve, though in some instances an angle is formed, where the fold crosses the lower palpebræ, and the deformity thereby increased. This singularity seems to depend upon the variable form of the bony orbit at different periods of growth; for it is more frequent, and more strongly marked amongst children, than in those of mature age, and more so in the latter than in advanced age.—Mr Barrow, in his Travels, likewise notices some such peculiarity in the eyes of the Chinese.

"The hair of the head is straight, coarse, and black, or brownish-black; beard for the most part scanty, but there are remarkable exceptions; no whiskers; skin is brownish-white in childhood; many of the youthful of both sexes exhibit a permanent rosy blush on the cheek, which the young women,

who occasionally wash the face, preserve a considerable time. In general, the natural colour of the skin soon disappears, and is replaced by an indelible yellow hue, the effect of its being, from early infancy, imbued with oil and filth, which are rarely removed.

" The stature of the men varies between 4 feet 11 inches and 5 feet $9\frac{1}{2}$ inches. The average height is about 5 feet 4 or 5 inches. That of the women is rather under 5 feet. Both sexes are tolerably well-formed, and rather muscular; hands and feet remarkably small. No instances of personal deformity were noticed."

The inhabitants of China are also included in this class. The head of the Chinese is generally of a conical form; the face triangular; the chin sharp, and with the upper jaw projecting a little beyond the under; the eye-brows are much arched; the eye is narrow, oblique, elongated, and half closed, and the root of the nose is broad. The countenance is generally pleasing, excepting that of the females of the lower ranks of society. Mr Barrow has described them " as being invariably coarse, ill featured, and of a deep brown complexion, like that of the Hottentots." According to the Jesuits, China was peopled by a colony from Egypt; and, according to Sir. W. Jones, they are the descendants of a military caste of *Hindoos*, called *Chinas*. Pauw has distinctly proved the dissimilarity between the *Egyptians* and *Chinese;* and the distinctions between the bodily form and customs of the *Chinese* and *Hindoos* may also be proved; and besides, the historical records of China go much farther back than those of the *Chinas*.

Dr Barclay lately shewed me an excellent specimen of a skull, which was dug up from an old burying-ground at *Macao*.

Of the Fourth, or American Class.

In this class, Blumenbach has included all the natives *of America*, excepting the Eskimaux.

In so extensive a class, it may be well imagined that there

is much variety in the form of the head, as well as in the complexion and features. The general characters are the following:—The complexion is of a reddish-brown or copper-colour. In the form of the head of the aboriginal inhabitants there is much variety; and, in many instances, it is altered by art, as has been already observed. The face is flat and broad, but not so much so as in the *Mongolian Class*; the cheek-bones are high, the nose is prominent, the mouth is large, the eyes are brown, and lodged deeply in their sockets.

I have two casts of *American Indians;* and, in these, the forehead cannot be said to be much depressed, (I have seen it much more so in the skulls of the natives of this country, and in one particularly, which was found in digging out the foundation for our new Library, and which had belonged to a person who had existed 400 years ago); but, in both casts, the forehead is considerably narrower than in the greater number of European skulls; the face is broad across the cheek-bones; the other bones of the face are large; also the cavity for the nose, and the sockets for the eye. The measurements are as follows:—From the root of the nose to the most prominent part of the os occipitis, the distance is $6\frac{1}{2}$ inches in both casts; and in both, the back-part of the head had been evidently compressed. The breadth from the most prominent part of the one parietal bone to that of the other, is equal to $5\frac{2}{8}$th inches in one of the casts, and in the other, to $5\frac{3}{4}$ths of an inch.

Dr Richardson informed me, that, during his travels, along with Captain Franklin, through the northern parts of America, he had met with three distinct tribes of Indians, who spoke different languages; all of these somewhat resembled each other; the countenances of the men were more different than those of the women, and some of the former had aquiline noses. The form of their heads was somewhat like that of the Eskimaux; the forehead was remarkably narrow, but not low, nor was there any appearance as if pressure had been applied to flatten it; indeed, he assured me, that no such custom prevailed amongst these northern In-

dians, though, as has been stated above, it prevails amongst the Indians that live more to the south.

In complexion, these Indians are fairer than the Eskimaux. Like the more southern Indians, they frequently made studied speeches, when they wished to obtain a favourite object.

Cook *, Hearne †, Humboldt ‡, Lewis and Clarke ||, represent this class as having a low forehead; and, according to Humboldt, the *Chaymas* consider a narrow forehead as beautiful.

A very interesting account of different Indians in the vicinity of the Rocky Mountains has been very lately published by Mr Edwin James, of which the subjoined is an extract.

" In form, the Missouri Indian is symmetrical and active, and in stature equal, if not somewhat superior, to the ordinary European standard; tall men are numerous.

" The forehead retires remarkably backward, and the posterior part of the head (occiput) has a flatness of appearance, attributable, perhaps, to the circumstance of its having rested so constantly during infancy on the surface of a board, or on the scarcely less yielding interposed pad or pillow. Yet that organ, to which, in the phrenological system, the seat of amativeness is referred, although not usually very prominent, is still marked and distinct.

" The *facial angle* of the cranium has been represented by Blumenbach at 73°, an obliquity which induced him to place the American Indian in his series of the varieties of the human race, as the fourth in number. *But his observations were made upon the cranium of a Carib*, than which people, as Humboldt justly remarks, " there is no race on the globe in which the frontal bone is more depressed backwards, or which has a less projecting forehead." This obser-

* Captain Cook's Description of the Natives of Nootka Sound.

† Journey to the Frozen Ocean.

‡ Personal Narrative.

|| Travels, p. 64. when describing the Western Indians.

vation will not rigidly apply to the Western Indian, who certainly possesses a greater verticality of profile. Agreeably to the mensurations of Dr HARLAN, a cranium, which we obtained on the plains of the Platte, exhibits an angle of 78°, a *Wabash* male 78°, female 80°, and a *Cherokee* only 75°.

" The hair is coarse, black, glossy, and dense, upon the head, sparse and slender upon the chin, independently of the custom of extirpating it, but although the hair is certainly oval in its transverse section, yet we could not perceive that, in this respect, its proportions exceeded our own.

" The line of the direction of their eyes is nearly rectilinearly transverse, being in this respect intermediate between the arcuated line of the eyes of the white man and that of the Indians of New Spain, who, according to HUMBOLDT, have the corner of the eye directed upward towards the temples. The nose is generally prominent, and either aquiline or Roman, with the wings not more dilated than those of white men. This form of nose is so prevalent, as to be regarded as the most beautiful; it is no small compliment to tell a person that his nose is like that of a mule; and beauty is indicated in their language of signs, by placing an arcuated finger upon the face, in imitation of the aquiline curve. The pug nose, and the common form of the noses of the white Americans, of a concave outline, are regarded as remote from the standard of beauty. The lips are more tumid than those of the white Americans, but very far less so than those of the Negro. The lower jaw is large and robust; the teeth are very strong, with broad crowns. The chin is well formed. The cheek-bones are prominent, but not angular like those of the Mongul, and stamp a peculiarity on the contour of the face, characteristic of the American Indian. The expression of the countenance is austere, often ferocious *."

The eloquence of the Indian is very remarkable. My distinguished colleague the Reverend Dr BROWN (who is about to publish a History of North America), read to me, with

* Extract from vol. ii. of EDWIN JAMES's Expedition to the Rocky Mountains. See also vol. iii. of the same Work, p. 244., in which several other tribes of Indians are described.

much animation, several of their speeches and addresses, which I listened to with no less admiration than astonishment, for they are in the highest strain of eloquence.

Humboldt and Bonpland brought to Paris several crania of *Aturcs*, Mexican *Indians* and *Peruvians*, in which the frontal bone is very much depressed; and Humboldt has affirmed, "there is no race on the globe, in which the frontal bone is more depressed backwards, or which has a less projecting forehead, than the *American*." He has added, "This extraordinary flatness is to be found among nations, to whom the means of producing artificial deformity are totally unknown."

Of the appearance of two individuals of that tribe of people called in Brazil *Botocudoes*, I can speak from personal observation. About a year ago, a male and female of that tribe were exhibited in this city. The man died during his residence in Edinburgh, and I got a cast of his head.

The head is not deficient in point of size; for, in circumference, as taken by a string, it measures 23 inches on the cast, from which, perhaps, an inch should be deducted, on account of the thickness of the hair; and it measures from the root of the nose to the most prominent part of the occiput, rather less than 8 inches, for which $\frac{1}{2}$ should be deducted for the thickness of the hair; and from ear to ear, by the calliper compasses $5\frac{5}{4}$ inches.

The forehead, though not prominent, cannot be said to be low; and, indeed, is larger there than in some natives of this country, but it is narrow.

The bones of the face are large: the cheek-bones are broad, being equal to $5\frac{1}{2}$ inches, and seemed remarkably so, owing probably to his extreme emaciation before death.

The nose was aquiline; the orbits large, and the line of the face nearly straight; it retreated, however, somewhat near to the chin.

Prince Maximilian of *Wied-Neuwied*, procured a skull of a young man of that tribe, in describing which he has stated, that "the large piece of wood worn on the under lip, had not only pushed the lower fore-teeth out of their

places, but even pressed together and effaced the alveoli or sockets of the teeth in this youthful skull *." But that skull differs essentially in form from the head of the man who died in this city, whose head I had occasion to examine with care. All the teeth of both jaws were perfect; it appeared to me that the alveolar portion of the under jaw, which contains the incisor teeth, had been rendered flatter, by the piece of wood, with which the under-lip had been forced outwards. The piece of wood was circular, and of the same size as a half-crown piece.

Besides, the bones of the face are larger, and more prominent in the skull procured by PRINCE MAXIMILIAN, and the cranial part of the skull is rounder and shorter †, than in the head of the Botocudo I examined.

In order that the reader may form an opinion as to the proportion of the head to the rest of the body, it may not be improper to add, that the Botocudoes exhibited in this city were of middle stature. According to Prince MAXIMILIAN "both men and women are entirely destitute of clothing; the former were of middle size, strong, muscular, and well made, yet, in general, rather slender; but the great plugs of wood in their ears and lips disfigured them greatly ‡."

Prince MAXIMILIAN has made particular mention of their muscular power, and ability to endure fatigue. "Their muscular strength enables them to go very swiftly in the hottest weather, both up and down hill; they penetrate the thickest and most entangled forests; they wade and swim through every river, if it be not too rapid; perfectly naked, therefore not incommoded by clothing; never getting into perspiration; carrying only their bow and arrow in their hand, and with their hardened skin, which fears neither thorns nor other injury, they creep through the smallest gap in the

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* Travels in Brazil, p. 312. 1820.

† See a representation of the Skull in BLUMENBACH's 6th Decade.

‡ Travels, pages 291.—293.

bushes, and can thus pass over a great extent of country in a day. My hunters had experience of this their bodily superiority."

Of the Fifth or Malay Class.

This class includes the inhabitants of Sumatra, Java, Borneo, New Guinea, New Zealand, New Holland, Van Dieman's Land, and the Islands of the Pacific Ocean. The complexion of these people is brown; hair black; cranial part of head small, but the bones of the face and mouth, and lips and teeth, are large.

The great intercourse which subsists between New Holland and Great Britain, has rendered us very familiar with the appearance of the natives of that great island. Through the medium of my friends, I have got a complete skeleton of a native of that country, and also three skulls; and in the Museum of Natural History and of the Phrenological Society, there are four or five specimens of that remarkable people.

The aborigines of that island hold but a low place in the scale of human beings, and they have gained but little by their intercourse with more civilised society.

In complexion, they are dark brown or black, have the features of the African, viz. prominent cheeks, broad and flat nose, large nostrils, very wide mouth, and very thick lips; the hair is jet black, which is often matted, as it were, into ropes, which hang about the head like a mop.

The skull is composed of hard, compact, dense, and heavy, materials; it is thicker than in most Europeans, and its surface is very uneven; the indentations on it have probably been occasioned by their clubs, or *waddeis*, with which they often fight with each other.

The cranial part of the skull is small in proportion to the bones of the face; the head is short from before to behind (vide measurements, Table II.), and narrow, notwithstanding the remarkable projection from the occipital bone, but it does not seem as if it had been compressed laterally. There is a larger proportion of the skull before than behind the meatus auditorius externus.

The frontal sinuses are large, very prominent, and overhang the orbits in a striking manner, giving indeed, a very peculiar, and, I should say, characteristic, appearance to the skull. The sides of the skull are flat, and the temporal fossæ are deep, but not so much so as in the Negro.

The ridges from which the temporal muscles take their origin are high and well deepened.

The form of the occipital bone in three of the specimens is remarkable.

The fossæ for the hemispheres of the cerebellum are flat, and terminate in an apex of three inches broad.

In two of my specimens a transverse suture divides the os occipitis into two portions, not exactly equal in size; and it may be remarked, that a similar division of the os occipitis takes place in two *Eskimaux skulls*.

The upper and under jaws are much imprinted by the muscles: the former is more prominent than in the European, but much less so than in the Negro, but the under jaw projects, instead of retreating, at its mental portion.

The opposite plate of the alveolar processes of both, or of one only, of the incisor teeth, are generally in contact, so that there is no socket for the roots of these teeth, which it is the custom of that nation to knock out at the period of puberty.

The orbits are somewhat of an oblong square form, and broader from side to side than in a vertical direction.

The ossa nasi are short and flat.

The cavity for the nose, and the ossa turbinata, are larger than in the European, and the form of the bottom of the nose is quite peculiar to this nation and the natives of Van Dieman's Land, for, instead of being flat, it slopes downwards and forwards. This race of people possess a very acute sense of smell, which is probably to be imputed to the large size of the nasal cavity.

The teeth are large, but not so prominent as in the Negro.

The palatine arch of the superior maxillary bone is longer and deeper than in any other skulls I have seen, excepting in those from Van Dieman's Land.

All the foramina for the bloodvessels or nerves at the base of the skull, are larger than in the European.

In short, there are several distinctive characters between

the skulls of the New Hollander and Negro from Africa. The cranial part of the skull of the former is larger, but more depressed on each side of the sagittal suture. The os frontis is not so much depressed; the frontal sinuses are more marked; the temporal fossæ are not so deep as in the Negro and Carib; and the temporal muscle does not take its rise so high on the side of the head; the nose is scarcely so flat; the upper-jaw bone is not so large and prominent; the incisor teeth are not so oblique; those of the upper-jaw do not project beyond those of the under-jaw; and the under-jaw does not retreat as in the Negro skull.

Still more remarkable differences may be observed in other parts of the skeleton *, which leads me to observe, that the aborigines of New Holland are probably not of Ethiopian origin; they have not the woolly hair of the African, and are far less intelligent. They had neither houses nor clothing; were totally ignorant of agriculture, and did not practise any one of the arts of civil life. Though much pains has, for thirty years, been taken to instruct them, not one of them has been induced to avail himself of his education; and, indeed, those who in early life have had the advantage of education, generally flee to the woods, when they arrive at manhood. In short, they hold a much lower place in the scale of being.

The natives of Van Dieman's Land bear a strong resemblance to those of New Holland; but they differ from them in having woolly hair; in being still less disposed to civilization, and in being inferior in point of intellect.

According to Collins, they do not worship the sun, moon or stars. "I never," says he, "could discover any object, either substantial or imaginary, that impelled them to the commission of good actions, or deterred them from the perpetration of what we deem crimes. There, indeed, existed among them some idea of a future state, but not connected in anywise with religion, for it had no influence whatever on their lives and actions."

Peron has described them as without chiefs; without laws or regular government; without arts of any kind; as possess-

* Vide Supra, p. 23. and 82.

ing no knowledge of agriculture; as being quite naked, and having no fixed abode *.

I have had an opportunity of examining three skulls from Van Dieman's Land, all of which were very similar to each other, and to those of the natives of New Holland, but rather of a smaller size. Vide Table II. Nos. 18, 19.

The bone is white, of a close texture, hard, and consequently heavy, and the skull is thicker than that of the European.

The frontal sinuses are not so conspicuous; nor are the upper and under jaws so large as in the natives of New Holland. The grinding teeth are of a most extraordinary size, and considerably broader than those of the Caffre, Esquimaux, or natives of New South Wales, and were in the three skulls considerably worn down.

The sockets of the incisor teeth are quite entire, so that the same custom of knocking out one or both of these teeth does not prevail in Van Dieman's Land.

The sockets of the eyes are rather small, but the cavity for the nose is larger than in the natives of New Holland; and is equal to that of the Carib. The ossa turbinata inferiora are large and prominent, and remarkably unequal on their surfaces. The foramina at the base of the skull for the nerves and bloodvessels are larger than in the European.

The canibals of *New Zealand* are included also in this great class. "Captain CRUISE has observed †, that the most striking in appearance was *Jetoro*, a man one would imagine in his 45th year. He was 6 feet 2 inches high, and was perfectly handsome both as to features and figure, though very much tatooed. The benignity and even beauty of his countenance were not destroyed by this frightful operation."

The other seven were very young men, all more or less tatooed, according to their ages, and varying in height from 5 feet 8 to 5 feet 10 inches. In colour, they were little darker than Spaniards, strong, active, and well limbed, and their hair straight, with the exception of *Jetoro's*, which was curly.

Captain CRUISE has remarked ‡, that when the men use vio-

* Voy. du Decouv. de Terres Austral. tom. i. chap. 30.

† Vide his Journal of his residence in New Zealand. London 1823.

‡ Journal in New Zealand.

lent exercise, they strip themselves naked, retaining only a belt, with which they gird their waists very tight. Fulness in this part of the body is unknown among them, and when seen in Europeans, excites much ridicule. When they go to war, or when they wish to appear to the greatest advantage, they paint their bodies red with a composition of oil and ochre; their hair is also oiled, fastened in a bunch on the top of their heads, and ornamented with the feathers of the *gannet* or the *albatross*, and a bunch of the more downy feathers of these birds is usually fastened in one ear. Their ears are always pierced during their infancy, and particularly those of the women. The perforation is gradually distended by means of a piece of stick passed through it; and the larger it becomes the more ornamental it is considered. From it the better class of people suspend the tooth of a particular fish, rather scarce on this coast; and so punctilious are the persons authorised to use this distinction, that the *Cookee* dares not under any circumstance infringe upon the prerogative. They also wear, fastened round the neck, by a cord, and hanging on the breast, a piece *of green talc* carved to represent what cannot be deemed human"; they attach much value to it, not from any superstitious notion, but from its antiquity; and it is hereditary in families. The dress of the women is precisely the same as that of the men; among the latter nudity at any time, or on any occasion, is not considered indecorous, but a dereliction of feminine modesty by the former is seldom known. The females are slightly tatooed upon the upper lip in the centre of the chin, and above the eyebrows. Some of them have a few lines upon their legs. A woman was seen at Shukehanga, who was described as having come from a place far to the southward of it, having lines on her breast, not unlike the links of a chain; while a female prisoner of Krokros was tatooed almost as much as a man.

The New Zealand women are as fair as those of the southern parts of Europe, well made, and in general handsome.

Before matrimony, concubinage is scarcely considered a crime, nor is it an impediment to the highest connection; after it they are faithful and affectionate wives, and very fond of their children. They bear with the greatest patience the

violent conduct of their husbands, who, considering women as beings infinitely inferior to t hemselves, oftn treat them with great brutality *.

The New Zealander differs very essentially in appearance from the *New Hollander*, or native of Van Dieman's Land. My description is drawn from five specimens. The skull is thick, hard and heavy. The cranial part of the skull bears a large proportion to the bones of the face; the frontal bone is not much depressed, and is rather broader from side to side than that of the Negro, but not so much so as in the European.

The temporal muscles take their rise high upon the sides of the head. The occipital bone is by no means so convex as in the European. The breadth of the head before the ear is greater than that behind it. The ear is rather small, and placed high up in the head.

The bones of the face are prominent, the cheeks broad, the face across the cheek bones measuring $5\frac{1}{2}$ inches. The spine at the roots of the zygomatic processes of the temporal bones are unusually prominent.

The teeth are not larger than in the European skull. In one of the specimens they were smaller, excepting the canine teeth of the under jaw; and in another they were excessively worn down, though there was not a grey hair in the head. The mouth is not so large, nor are the lips so thick, as those of the Negro, or native of New South Wales. The chin does not retreat as that of the Negro. The hair is long, straight, and of a jet black colour.

The natives of the *Pelew Islands* may be comprehended in this great class. To the classical pen of Mr KEATE, we are deeply indebted for a most interesting account of the natives of the *Pelew Islands*, a people widely different from those last described, and possessing in a striking degree all the more amiable dispositions of the heart.

What a contrast do these people present to the inhabitants of New Zealand, Australasia, or Van Dieman's Land? In coun-

* Journal in New Zealand, p. 282.

tries, says Mr KEATE *, which science or the gentler arts, have never reached, we observe a wonderful disparity. Some are found under that darkness, and absolute barbarism, from the sight of which humanity gladly turns aside, whilst others, unaided, unassisted, but by mere natural good sense, have not only emerged from this gloomy shade, but have nearly attained that order, propriety and good conduct, which constitute the essence of *real* civilization.

PRINCE LE BOO, whose portrait adorns Mr KEATE's book, is represented as having a large forehead, large eyes, broad face, rather short nose, and wide nostrils, and a large mouth. The character of this amiable Prince has been most emphatically given by Dr C. SMYTH, in his letter to Mr KEATE, in which he has described that Prince's death. "Though you cannot bring him back to life, you are called upon, (particularly considering his great attachment to you) not to let the memory of *so much virtue* pass away unrecorded."

Mr KEATE has thus described the natives of the *Pelew Islands.*

It was observed that all their teeth were black, and that the betel-nut and chinam, of which they had always a quid in their mouths, rendered the saliva red, which, together with their *black teeth*, gave their mouths a very disgusting appearance. They were of a middling stature, very straight and muscular, their limbs well formed, and had a particular majestic manner in walking; but their legs, from a little above their ancles to the middle of their thighs, were tatooed so very thick, as to appear dyed of a far deeper colour than their skin; their hair was of a fine black, long, and rolled up behind, in a simple manner, close to the back of their heads, and appeared both neat and becoming. None of them, except the younger of the King's two brothers, *had a beard*; and it was afterwards observed, in the course of a longer acquaintance with them, that they in general plucked out their beards by

* Vide Introduction, p. 7.

the root; a very few only, who had strong thick beards, cherished them and let them grow.

My friend Sir A. Halliday sent me, a few years ago, a skull of a most extraordinary form. Dr Spurzheim, to whom I shewed it, declared it to be the greatest curiosity he had examined. Most unfortunately, I could not gain exact information as to the place where it had been procured. All that is known about it is, that it had been procured in one of the islands of the South Seas. This skull is not of the same compact texture as that of the Negro. It is of a loose texture; and, in proportion to its large size, is light. The cranial part of the skull is large, in proportion to the bones of the face, which are rather small. The forehead is very flat, though not so much so as that of the Carib of the Island of St Vincent's. There are four small risings upon the frontal bone. The top of the head is flat, and there is an evident depression between the frontal and parietal bones, in the line of the coronal, sagittal, and lambdoidal sutures. The parietal bones are remarkably prominent; they bulge out so much, at the sides of the original centres of ossification, that the space between the coronal and lambdoidal sutures is equal to 3 inches only; and the distance between the most prominent portions of the parietal bones of the opposite side, is equal to $6\frac{9}{10}$ths of an inch; whereas, the distance from the root of the nose to the most prominent part of the occiput, is equal to $5\frac{1}{2}$ inches: the usual proportions of the skull are therefore reversed. The measure, by a string stretched across the top of the head from the origin of the one zygomatic process to that of the opposite side, was equal to $12\frac{4}{10}$ths of an inch.

The occipital bone was by no means so convex as usual above its greater arch, and it did not project beyond the parietal bones above an inch. Hence the distance from the fore-edge of the meatus auditorius externus, to the most prominent part of the upper jaw-bone, is equal to $4\frac{1}{2}$ inches; but the distance between the most prominent part of the os occipitis and back-edge of the meatus auditorius externus, is equal to $2\frac{3}{4}$ inches only.

There is an evident depression in the os occipitis behind,

which is of a triangular form, and which seems to me to have been occasioned by external pressure. There is also a bulging out of the squamous portions of the temporal bones, especially over the mastoid processes of the temporal bones; and also a slight bulging out of the temporal fossæ of the frontal bone. The distance between the mastoid processes is equal to $4\frac{1}{2}$ inches. The bones of the face are not like those of the Negro; they are not prominent and narrow, and not much impressed by the muscles: the ossa maxillaria superiora over the antra maxillaria are remarkably concave, and the sockets for the teeth are very small. Instead of a broad ring around the orbits, as in the skull of the New Hollander and Negro, there is merely a sharp ridge of bone. The breadth between the orbits is considerable; it is equal to $1\frac{1}{8}$th of an inch; and the ossa nasi, at their juncture with the os frontis, are very flat, as also the surface of the os frontis, with which they are in contact. The zygomatic processes of the cheek-bones are long and slender, and not much elevated. The peculiar form of this skull seems to me to have been the result of pressure applied artificially: Thus the occipital bone had been flattened, and also the frontal bone; and, to compensate for the loss of space before and behind, the parietal bones had been forced outwards, whereby the distance between these bones was considerably augmented, and *rendered greater* than the distance from the fore to the back part of the skull, or between the frontal and occipital bones: hence, in this skull, the *usual proportional distances of the skull are reversed.*

I have included in this class the natives of *Ceylon*, concerning whom I have received much important information from my friend Dr John Davy, who resided for four years in that island, and has published a very interesting account of it, which is embellished with an engraving of a skull of a native. He has informed me, that he could not perceive any remarkable difference in the form of the head from that of the European; he had heard it alleged that the skull is longer than that of the European, but he is not persuaded that it is so.

In Table II., the reader will find the measurements of

the skull of that rebel *Kandian Chief* KAPITAPOLA, which was presented to the Phrenological Society by Mr MARSHALL. The upper jaw is more prominent than in the European; but Dr DAVY considers this to be peculiar to the individual, and by no means a characteristic feature of this nation at large. Dr DAVY added, he knew this rebel chief well, and had heard his defence when he was brought to trial, which, considering the very short time he had to prepare it, was a very able one; and, on the whole, he considers the Singalese to be an intelligent people.

The inhabitants of this island, according to Mr MARSHALL, and "particularly those of the higher classes, are remarkably well made; compared with Europeans they have short necks*."

I have subjoined a very brief notice as to the form of the skull of several of our countrymen, who had probably lived during the 12th and 13th centuries. A considerable number of skulls were found in digging out the foundation (February 1824) for the new Library of the University, which place, according to tradition, had been the burying ground of the *White Friars* 500 years ago.

I procured ten of these skulls, which exhibit all the varieties in point of form which exist at this day.

One of them is most remarkably long, measuring from the os frontis to the os occipitis $7\frac{1}{2}$ inches; but it is not proportionally broad, for, from the meatus auditorius externus of one side, to that of the opposite side, it measures only $4\frac{2}{8}$ inches. In point of form it is very similar to that of the Egyptian mummy which was filled with pitch, of which the measurements are given at page 208.

The forehead of one of the other skulls is not unlike to that of the Carib: the os frontis is remarkably low, but there is no appearance as if artificial pressure had been employed to flatten it.

The teeth in all the skulls were less decayed than the other bony parts, and had better resisted the influence of time, which is a strong argument against the identity of the bony part of the tooth and bone in general.

* Notes on the Medical Topography of Ceylon.

All of the skulls were of a reddish brown colour, and in a moist state: several of them cracked when dried.

Dr Davy was so polite as to examine chemically, the cuneiform process of the occipital bone of one of the skulls, and found that it contained some animal matter, with a less proportion than recent bone, and the animal matter appeared to be entirely cartilage or condensed albumen, without any oil. It may be deserving of notice also, that the earthy part of this bone had apparently undergone a slight change, for it contained scarcely any trace of carbonate of lime.

I shall conclude this very imperfect sketch in the language of Mr Keate: "The inquisitive mind of man," says that distinguished author, "too eager after knowledge which his limited faculties can never reach, often *idly asks, Wherefore all these varied gradations in human existence?* But his question will for ever remain unanswered; and he must content himself with being satisfied, that the ways of Providence are conducted with unerring wisdom, to answer purposes beyond mortal comprehension. He will be far more wisely employed in feeling with becoming gratitude, that he was not destined himself to be an inhabitant of *Terra del Fuego*, or to add one to the number of forlorn savages of the *Northern Pole.*"

CHAP. XIII.

GENERAL OBSERVATIONS ON THE EXTREMITIES.

According to Vitruvius,

1st, In a well proportioned man, whose arms are stretched out, the distance between the extremities of the fingers of the right and left hands, should be equal to his height, and his figure therefore may be included in a square.

2d, When the legs and arms are moderately extended, the ossa pubis are about the centre of the body, or the ossa pubis form the centre of a circle, the circumference of which touches the extremities of the fingers and toes.

3d, The distances between the top of the shoulder and symphysis pubis, from the symphysis pubis to the top of the knee, and from thence to the inner ancle, should be equal in a well proportioned man.

In a former chapter, the peculiarities of the human pelvis have been described, to which those of the inferior extremities have an immediate relation.

I made no mention of the pelvis of the quadruped, being persuaded that man only can be said to have a pelvis, for even in the monkey tribe, the os sacrum is not curved as in man, and is not calculated to give support to the bowels included within the pelvis, the ossa innominata are small and elongated, and do not form, as in man, a large basin-like cavity.

There is a general resemblance between the bones of the upper and under extremities, as to the number, position and relation of their several bones, and in the construction and directions of their articulations.

The differences in the bones of the extremities concur in proving man to be biped. This is obvious from the disproportion in the respective lengths of the superior and inferior extremities: the lower extremities by their size are evidently intended as pillars of support, whereas the upper extremities are admirable organs of apprehension; and are fixed to the sides of the trunk, that they might be more useful as organs of apprehension.

Man alone, as ARISTOTLE has most justly observed, can be said to have hands, which, on account of their admirable construction, he called the Organ of organs.

The lower limbs of a monkey are, comparatively to his body, shorter and weaker, and the upper limbs are proportionally much longer, and in the gibbon touch the ground, when the animal is erect. The hands and feet are proportionally longer, and also narrower, that the animals may be better enabled to lay hold of the branches of trees.

Thé lower limbs are firm columns, well calculated to support the weight of the body.

The thigh bones are placed directly under the pelvis: their axis corresponds with the centre of gravity of the body, whereas the thigh-bones of the inferior animals form an angle with the spine; which in many animals is acute.

Owing to the greater breadth of the pelvis, and length of the necks of the thigh-bones, the legs may be separated to a greater distance than in any of the inferior animals; thus the centre of gravity is made lower, and we are more secure, in the erect posture.

The scapula are moveable, but the ossa innominata are firmly fixed.

The glenoid are shallow cavities, and are directed outwards, and those of opposite sides are kept at a considerable distance from each other by the collar-bones; whereas the acetabula are deep cups, and are directed downwards.

The ossa humeri are much shorter and thinner than the thigh-bones, and much less securely fixed by ligaments. The two bones of the fore arm are nearly of equal size, and the one of these, the radius, may be called a bone of the hand; it rolls readily upon the other, whereas the bones of the leg are very disproportionate in size, the larger being a firm pillar of support, and the smaller possessing but a very slight degree of motion; it is calculated rather to increase the surface from which the muscles which move the ancle and foot take their rise, than to give additional support to the body.

The bones of the wrist and ancle are very different; the former admits of considerable latitude of motion sideways, but at the ancle joint the motion is very much limited.

The hand is on the same line with the fore arm; the thumb is very moveable, and partakes of the varied movements of the hand; and, by its greater size in man than in the inferior animals, renders the human hand greatly superior as an organ of apprehension to that of the inferior animals, for in these the thumb is slender and weak. In all the monkey tribe, the fore-paws are excellent instruments for grasping the branches of trees, and they may be said to be four handed; many of the

monkey tribe are provided with another organ of apprehension, a prehensile tail. The broader part of the human foot is placed at right angles to the bones of the leg; it projects considerably backwards, forming a broad basis of support, and presents a large surface of connection for the extensor muscles. The form, size, and position of the heel-bone, distinguish man from the inferior animals. The foot gradually increases in breadth towards the toes, which adds to the width of the basis. The bones of the great toe have comparatively little motion, are parallel to the bones of the other toes, and constitute a firm support to the weight of the body: its movements are much more limited than those of the thumb, because the great toe is one of the props on which the body is supported.

In short, there are combined in the human foot greater stability and surface than in any other animal.

The human foot applies accurately to the inequalities of the surface of the ground; the whole surface of the tarsus, metatarsus and toes touches the ground: whereas the feet of monkeys rest on their outer margin, in order that they may employ the thumb and long hinder toes, as organs of apprehension, for the taking hold of the branches of trees, in climbing. The feet of quadrupeds that have hoofs are contracted and elongated, and they touch the ground merely with the point of the foot; and these bones, which correspond with our os calcis, are placed in a perpendicular direction to the other bones of the foot.

Lastly, the human foot is concave, lest in our erect position the muscles, tendons, bloodvessels, nerves, and absorbent vessels, should be pinched by the erect position.

SECTION I.

OF THE BONES OF THE SUPERIOR EXTREMITIES.

The superior extremities consist of the Shoulder, Arm, Fore-arm, and Hand.

The shoulder consists of the Scapula and Clavicle.

Of the Clavicle.

The Clavicle or collar-bone is in form like to an italic *S*, placed nearly horizontally between the upper lateral part of the breast-bone and top of the shoulder.

The clavicle is an accessory bone, tending to prevent the arm from falling forward upon the breast-bone. It also encreases the sphere of action of the arm, by enabling it to describe portions of a circle, the centre of which is the connection of the clavicle with the breast-bone.

The clavicle is not proper to all animals: it is not found in those quadrupeds in which the weight of the body is supported by the fore legs, but only in such, as the mole, squirrel, hedgehog, rat, sloth, and bat, that employ the fore legs as organs of apprehension, or in climbing or digging the ground, or in flying.

The extremities of this bone are larger than the middle of it.

The sternal extremity is of a triangular form; the angle behind is produced, so as to form a sharp ridge, to which the transverse ligament extended from one clavicle to the other is fixed *. The side opposite to this is somewhat rounded.

The middle of this protuberant end is as irregularly hollowed as the cavity in the sternum for receiving it is raised; and in a recent subject, a moveable cartilage, which in structure is like to the intervertebral cartilages, is interposed between the extremities of the bones, and there are short and strong ligaments which secure this articulation, independently of the strong ligament which extends from the one clavicle to the other; notwithstanding which, this end of the clavicle is sometimes dislocated.

The sternal end of the clavicle, for about two-fifths of its length, is bent obliquely forwards and downwards. On the upper and fore part of this curvature, a small ridge is seen, with a plain rough surface before it; from which a

* Winslow, Expos. Anat. des Os frais, p 248. Weitbrecht, Act. Petropolit. tom. 4. p. 255. & Syndesmolog. sect. 2. l. 3.

part of the sterno-hyoideus and sterno-mastoideus take their rise.

Near the lower angle there is a plain surface for the connection of the first rib, which rib and this bone are contiguous *, and are connected by a firm ligament †.

From this, a rough plain surface is extended outwards, which gives rise to a part of the pectoral muscle. The bone is flat, and is rough, for the insertion of the larger share of the subclavian muscle. After the clavicle begins to be bent backwards, it is round, but soon after becomes broad and thin, as far as the acromial extremity. Along the external concavity, the bone is rough, from which a part of the deltoid muscle takes its rise: Opposite to this, on the convex edge, there is a scabrous ridge, to which a share of the cucullaris muscle is fixed. The upper surface of the clavicle is flat; but the lower is hollow, and lodges the beginning of the musculus subclavius; and towards its back-part there is a tubercle, to which a strong short ligament connecting this bone to the coracoid process of the scapula is fixed.

The acromial end of this bone is oblong, smooth, sloping at the posterior side, and tipped in a recent subject with a cartilage, for its articulation with the acromion scapulæ. The bone is spongy at each extremity, for the firmer connexion of the ligaments.

This acromial end of the clavicle is very firmly connected with the scapula, and is very seldom separated from it by external violence.

It is evident from the situation, and form, and office, of the clavicles, that they are very liable to be broken, and when broken, the broken parts generally cross each other. A luxation at the acromial extremity of the clavicle is very rare, on account of the mobility of the scapula; whereas the dislocation at the sternal extremity is not unfrequent, on account of the shallowness of the articular cavity of the breast-bone. The

* Dionis, Sexieme Demonst. des Os.

† Weitbrecht, Syndesmolog. sect. 2. I. § 7.

extremity of the clavicle is thrown forwards or backwards, and when in the latter situation, it presses on the gullet, and creates the most urgent symptoms.

Of the Scapula.

The SCAPULA, or shoulder-blade, is of a triangular shape, situated on the outside of the ribs, with its longest side, called its base, towards the spinal processes of the vertebræ, and with the angle at the upper part of this side about three inches, and the lower angle at a greater distance from these processes. The thin ends of the serratus anticus major, and subscapularis muscles, are interposed between the scapulæ and the ribs: But as this bone advances forwards, its distance from the ribs increases. The upper or the *superior costa* of the scapula is nearly horizontal, and parallel with the second rib. The lower or the *inferior costa*, is extended obliquely from the third to the eighth rib. Such is the situation of this bone, when the arms are not employed. The inferior angle of the scapula is very acute; the upper one is near to a right angle; and what is called the anterior, does not deserve the name, for the two sides do not meet to form an angle. The body of this bone is concave towards the ribs, and convex behind. The scapula at its posterior part is divided into two unequal portions, by the large spine that rises from its convex surface behind. A process stands out from the fore part of the upper side; which, from its imaginary resemblance to a crow's beak, is named *coracoides* *.

The base, which is tipped with cartilage in a young subject, is not all straight: For above the spine, it runs obliquely forwards to the superior angle, lest by the projection of it backwards, the muscles and skin had been injured. At the root of the spine, on the back-part of the base, there is a triangular plain surface, which is formed by the pressure of the lower fibres of the trapezius. Below this, the edge of the scapula is scabrous and rough, for the insertion of the serratus major anticus and rhomboid muscles.

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* Anchoroides, sigmoides, digitalis ancistroides.

The back-part of the inferior angle is made smooth by the latissimus dorsi passing over it. This muscle also alters the direction of the inferior costa some way forwards from this angle. The inferior costa in its progress forwards becomes thicker, and is excavated for receiving the teres minor, and there is also a depression in the under part of it for the subscapulary muscle; and between the two a ridge with a small depression appears, where the long head of the triceps extensor cubiti takes its origin.

The superior costa is very thin; and, near its fore-part, there is a semilunar notch, across which a ligament is stretched; and sometimes the bone is continued, to form one, or sometimes two holes, for the passage of the superior scapulary blood-vessels and nerves. Immediately behind this semilunar cavity, the coraco-hyoid muscle has its rise. From the notch to the termination of the fossa for the teres minor, the scapula is narrow, and forms a part of the neck of the bone.

The cavity behind the spine is concave, where the supra-spinatus muscle is lodged; but the surface of this bone, below the spine, on which the infra-spinatus muscle is placed, is convex, except a fossa that runs at the side of the inferior costa.

The internal or anterior surface of this bone is hollow, except in the part above the spine, which is convex. The subscapularis muscle is extended over this surface, where there are several ridges and intermediate depressions.

The spine is small at the base of the scapula, and becomes higher and broader as it approaches the shoulder-joint. On the sides, it is unequally hollow and crooked. Its ridge is divided into two rough flat surfaces: into the upper one, the trapezius muscle is inserted; and, into the lower, a part of the deltoid is fixed. The end of the spine, called *acromion*, or top of the shoulder, is broad and flat, and is sometimes only joined to the spine by a cartilage. The anterior edge of the acromion is flat, smooth, and covered with a cartilage, for its articulation with the clavicle; and it is hollowed below, for the passage of the infra and supra spinati muscles, and free motion of the os humeri.

The coracoid process is crooked, with its point inclining forwards; so that a hollow is left at the lower side of its root, for the passage of the infra-scapularis muscle. The end of this process is marked by three plain surfaces. Into the internal, the serratus minor anticus is inserted: From the external, the short head of the biceps flexor cubiti rises; and, from the lower one, the coraco-brachialis has its origin. At the upper part of the root of this process, immediately before the semilunar cavity, a smooth tubercle appears, where a ligament from the clavicle is fixed. From the external side of this coracoid apophyse, a broad ligament goes out, which becomes narrower where it is fixed to the acromion. The acute pain, and violent inflammation attending contusions in this part, are probably owing to injury done to the tendons and ligaments.

The glenoid cavity, which constitutes the front of the neck bone, is in shape like to the longitudinal section of an egg, being broad below, and narrow above. Between the brims of this hollow and the fore-part of the root of the spine, a large sinuosity is left, for the transmission of the supra and infra spinati muscles; and, on the upper part of these brims, there is a smooth surface, for the origin of the second head of the biceps flexor cubiti. The medullary vessels enter the scapula near the base of the spine.

The scapula is of an unequal thickness. The neck and third process are thick and strong: The inferior costa, spine, and coracoid process, are of a middle thickness; but the body is thin and transparent. There are few cells between the plates of this bone.

The scapula and clavicle are joined by plain surfaces, tipped with cartilage, in order to admit of a slight degree of rotation, and are united by the common capsular ligament, and also by a very strong one, which proceeds from the coracoid process, but which divides into two, before it is fixed into the clavicle: or it can yield to the fore-part of the scapula moving downwards, while the back-part of it is drawn upwards; in both which cases, the oblong smooth articulated surfaces of the clavicle and scapula are not in the same plane, but stand

a little transversely, or across each other; and thus the risk of dislocation is averted, which would have been still more frequent, if either of the bones had moved on the other perpendicularly up and down, without any rotation. Sometimes a moveable ligamentous cartilage is found in this joint; in other cases, a cartilage is only interposed at the anterior half of it; and, in some old subjects, a sesamoid bone has been found here*. The scapula is connected to the *head*, *os hyoides*, *vertebræ*, *ribs*, and *arm-bone*, by muscles, that have one end fastened to these bones, and the other to the scapula, by which it may be moved upwards, downwards, backwards, or forwards. By the quick succession of these motions, its whole body is carried in a circle. But being also often moved, as upon an axis, perpendicular to its plane, its circumference turns in a circle, whose centre this axis is †. In these different movements, the outer end of the clavicle and the arm are carried along with it. The glenoid cavity of this bone receives the *os humeri*, which plays in it as a ball in a socket.

The scapula serves as a *fulcrum* to the arm; and, by altering its position on different occasions, presents to the head of the os humeri a fit socket to move in, and thereby extends the sphere of motion of the superior extremity, and increases the sphere of action of the muscles which rise from it, by altering their directions, in respect to the bone which they are to move. The scapula also serves to defend the back-part of the thorax.

The *base*, *acromion*, *coracoid process*, and *head* of the *scapula*, are cartilaginous at birth; and the three first are joined as epiphyses; while the head, with the glenoid cavity, is not formed into a distinct separate bone.

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* Jac. Sylv. Isagog. Anat. lib. 1. cap. 2.

† See Winslow, Mémoires de l'Acad. des Sciences, 1726.

Of the Os Humeri *.

There is only one long, round, and nearly straight bone proper to the arm, which has been called *os humeri*, the upper extremity of which is expanded into a large, round, smooth head, the axis of which is not in a straight line with the axis of the bone, but stands obliquely backwards from it, and is bounded by a circular fossa, into which the capsular ligament of the joint is fixed. Below the fore-part of its base there are two tubercles. The tendon of the subscapularis muscle is fixed into the smaller or internal tubercle. There are three plain surfaces upon the larger or external tubercle; into the anterior of which the *musculus supra-spinatus;* into the middle or largest the *infra-spinatus;* and into the one behind, the *teres minor*, is inserted. Between these two tubercles, exactly in the fore-part of the bone, there is a deep long fossa, for lodging the tendon of the long head of the *biceps flexor cubiti;* which, after passing through the joint, is tied down by a tendinous sheath extended across the fossa. There is a ridge on each side of this fossa. The tendon of the pectoral muscle is fixed into the anterior of these ridges; and those of the *latissimus dorsi*, and *teres major*, are inserted into the internal one. A little behind the lower end of this last, there is another rough ridge, for the insertion of the *coraco-brachialis*. From the back-part of the root of the largest tubercle, a ridge also is continued, from which the short head of the extensor cubiti rises. This bone is flat on the inside, about its middle. In the middle of this plain surface, the medullary artery enters the bone, and in a direction obliquely downwards. At the fore-side of this plane, the bone rises in a sort of ridge, which is rough, and often has a great many small holes in it for the insertion of the tendon of the strong deltoid muscle; on each side of which, the bone is smooth and flat, where the brachialis internus rises. The exterior of

* The humerus is supposed to be viewed in the pendulous position, with the palm of the hand directed forwards. In this position, those parts that look towards the radius are external; those towards the ulna internal; those towards the palm, anterior; and those towards the elbow, posterior.

these two flat surfaces is the larger; behind it, a superficial spiral channel, formed by the muscular nerve, and the vessels that accompany it, runs from behind, forwards, and downwards. The body of the os humeri is flat behind. Near the lower end of this bone, a large sharp ridge is extended on its outside, from which the musculus supinator radii longus, and the extensores carpi radiales rise. Opposite to this there is another small ridge, to which the aponeurotic tendon, that gives origin to the fibres of the internal brachialis muscle, is fixed; and, from a little depression on the fore-side of it, the pronator radii teres rises.

The body of the os humeri becomes gradually broader towards the lower end, from which there are several processes; at the roots of which there is a cavity before, and another behind. The anterior is divided by a ridge into two: the external, which is the least, receives the end of the radius; and the internal receives the coronoid process of the ulna, when the fore-arm is bended; while the posterior deep triangular cavity lodges the olecranon, when the fore-arm is extended. Betwixt these two cavities, the bone is so thin as to appear diaphanous in several subjects. The sides of the posterior cavity are stretched out into two processes, called *condyles;* from each of which a strong ligament passes to the bones of the fore-arm. The external condyle is directed obliquely forwards in respect of the internal, when the arm is in the most natural posture.

From the rough part of the condyle, the inferior head of the extensor carpi radialis, the extensor digitorum communis, extensor carpi ulnaris anconæus, and part of the supinator radii brevis, take their rise; and, on the smooth head, the upper end of the radius plays. The internal or more prominent condyle gives origin to a part of the flexor carpi radialis, the pronator radii teres, the flexor digitorum sublimis, and flexor carpi ulnaris.

A pully, having two lateral prominences, and a smooth cavity, is interposed between the condyles. When the fore-arm is extended, the tendon of the brachialis internus muscle is lodged in the fore-part of the cavity of the pully. In a

groove between the internal protuberance and the internal condyle, the ulnar nerve is lodged.

The shoulder-joint is so constructed as to admit of considerable latitude of motion, and in different directions; which depends upon the disproportion as to size between the head of the os humeri, and that of the glenoid cavity; the former being hemispherical, the latter of an oval shape; and also upon the length, thinness and looseness of the capsular ligament of the joint. The arm may be raised, depressed, and thrown forwards and backwards: and, by the succession of these different motions, a circle may be described. Besides which, the bone rotates round its own axis. But though this can be performed with the round head in all directions; yet, as these vary, the effects upon the body of the bone are very different: For, if the middle of the head be the centre of rotation, as it is when the arm hangs down by the side, the body of the bone is moved only forwards and backwards; because the axis of motion of the head is nearly at right angles with the length of the bone *; whereas, when the arm is raised to right angles with the trunk of the body, the centre of motion, and the axis of the bone, come to be in the same straight line; and therefore the body of the os humeri performs the same motion with the head.

The shoulder-joint, owing to its peculiar conformation, is more frequently dislocated than any other joint of the human body. According to the register kept at the Hôtel Dieu in Paris, the dislocations of the shoulder-joint are equal in number to those of all the others.

If the os humeri had rested upon an immovable bone, dislocations at the shoulder-joint must have been still more frequent; whereas the scapula yields, and thereby the effect of external violence is eluded to a certain degree.

But every part of the capsular ligament of the shoulder joint is not equally thin and equally liable to be torn: it is strengthened above by the deltoid muscle, by the tendons of

* Hippocrat. de Articul. § 1.

the biceps flexor cubiti, and supra-spinatus muscles, and receives great support from the acromion and coracoid processes of the scapula, and ligament, stretched between these processes internally, by the tendon of the subscapularis muscle, and externally, by that of the teres minor and infra spinatus muscles; hence the head of the os humeri may be more readily dislocated downwards and inwards, as the capsular ligament of the shoulder-joint is supported and strengthened in every other direction.

About seventy years ago, different opinions were entertained as to the state of the ligaments, when a joint had been dislocated. The greater number of writers joined HEISTER in opinion, that the capsular ligament is merely extended, when a joint has been dislocated.

With regard to the opinion of HEISTER, it may be observed, that a subluxation at the shoulder-joint has sometimes occurred in children of a very debilitated frame of body, from so slight an effort as the suddenly raising the arm; and the bone after a time regains its place without surgical aid, and with a crack.

Mr BRYCE informs me, that he knew a girl who had repeatedly dislocated the knee-joint in running; and so great was the degree of relaxation, that the patient used to sit down upon the spot, and replace the bones.

But in more advanced life, when the humerus has been dislocated, the capsular ligament is torn to such a degree, as readily admits of the replacement of the bone.

My Father's attention was directed to this disputed question, whilst he was prosecuting his studies in this city. He conceived, that, as the ligaments possess little or no share of elasticity, these must be ruptured, as they could not be stretched to such a degree as to admit of the displacement of the articular surfaces of the bone: he put his opinion to the test of experiment, and found, that after steeping the ligaments for some hours in tepid water, he could not produce a perfect dislocation, unless the ligaments were lacerated.

A few years afterwards, he had the satisfaction of verifying his former observations, by dissecting the joints of several persons, who during life had suffered from dislocation, and particularly by examining the shoulder of a man whose arm had been dislocated by falling from a considerable height: he also remarked that the muscles in the vicinity of the dislocated joint were displaced, and sometimes torn.

These observations of my Father have been fully confirmed by future observers, and especially by Sir Astley Cooper.

The os humeri may be dislocated in different directions:

1*st*, Downwards into the axilla, and when the head of the displaced bone rests on the inferior costa of the scapula.

2*d*, The head of the bone is displaced forwards under the pectoral muscle, or below the middle of the clavicle; or,

3*d*, The head of the bone is sometimes, though very rarely, displaced backwards upon the back part of the scapula.

Sir A. Cooper has described a 4*th* kind of dislocation, which "is only partial, when the anterior portion of the capsular ligament is torn through, and the head of the bone is found resting against the coracoid process of the scapula on its outer side *."

Twenty-five years ago, my Father intended to publish his observations on dislocations, and got ten plates at that time engraved for the purpose, but unfortunately he did not fulfil his intention. Four of these engravings illustrate the nature of the most common kind of dislocation of the shoulder joint.

The object of the first view is to shew the position of the head of the dislocated humerus, in respect to the great pectoral and deltoid muscles; the alteration in the form of the joint, occasioned by the displacement of the head of the bone, the angular appearance of the joint; the flattened appearance of the deltoid muscle, and its being lower than natural on the os humeri, and that the head of the os humeri is in the axilla.

* Page 416, 1st edition of his Treatise on Dislocations and Fractures.

In the second view, the great pectoral muscle has been removed, in order to shew the stretched biceps flexor cubiti, and coraco-brachialis, muscles, the relative situation of the displaced head of the bone in respect to the bloodvessels and nerves of the axilla, that the head of the bone presses on them, and had forced them backwards out of their natural situation, and that the deltoid muscle has been displaced, together with the ball of the os humeri,

The third is a deeper view of the shoulder-joint. The coraco-brachialis muscle and shorter head of the biceps, are seen crossing over the head of the dislocated bone. The tendons of the supra and infra spinatus muscles, and also that of the teres minor, are seen covered by condensed cellular substance. In this view, the musculo-cutaneous nerve is seen somewhat compressed by the head of the displaced bone; and as the dislocation had existed for some time, there was no visible rent in the capsular ligament.

The fourth and last view, was taken after the os humeri had been rolled outwards, and after opening a newly formed capsular ligament: there was a newly formed socket for the head of the bone; and in this instance there was an exostosis within the newly formed socket. The head of the os humeri lay on the inferior costa of the scapula.

My Father, in his lectures, used to state, that the biceps muscle proves the principal obstacle to the reduction of this dislocation, and therefore always recommended the fore part to be bent, in order to relax the biceps, before an attempt is made to reduce the dislocation. Sir A. Cooper does the same; he observes *: "I generally bend the fore-arm nearly at right angles with the os humeri, because it relaxes the biceps, and consequently diminishes its resistance."

Sir A. Cooper has (p. 422.) published a very interesting account of the dissection of a shoulder-joint that had been dislocated, and informs us, that he had found the supra spinatus muscle to be the principal obstacle to the reduction of the dislocated humerus.

* Page 427, 1st edition of his Treatise on Dislocations.

My Father had ascertained that the capsular ligament is torn in cases of dislocation, and also, that the rent in a ligament is not readily obliterated: hence a very slight cause may occasion a subsequent dislocation. There was a celebrated actress in this city who often dislocated her shoulder by so slight an effort as raising her arm in the exercise of her profession.

The lower end of the os humeri is articulated with the bones of fore-arm, and carries them with it in all its motions, and also serves as a base on which they move. Both the ends of this bone are cartilaginous in a new-born infant, and the large head, with the two tubercles, and the trochlea with the two condyles, become epiphyses, before they are united to the body of the bone.

Of the Fore-Arm.

In the subsequent account of the fore-arm, I understand, by the term of *posterior*, that part which is in the same direction with the back of the hand; by *anterior*, that answering to the palm; by *internal*, that on the same side with the thumb; by *external*, the side nearest to the little finger; supposing the hand always to be in a middle position between pronation and supination.

The fore-arm consists of two long bones, the Ulna and Radius, placed obliquely in respect to each other; that is, the ulna is not directly behind, nor on the outside of the radius, but in a middle situation between these two, and the radius crosses it. The fore-arm is, in proportion to the humerus, longer in the African than in the European.

Of the Ulna.

The Ulna, so named from its being used as a measure, is the longer of the two bones of the fore-arm, and situated on the outside of the radius.

At the upper end of the ulna, there is a process like a hook, the concave surface of which moves upon the pully of the os humeri, and is called *olecranon*. The convex back-part of it is rough and scabrous, for the insertion of the triceps exten-

sor cubiti. There is also a second process, which is sharp at its end, and therefore is named *coronoid.*

Between these two processes, there is a large semicircular concavity; the surface of which, on each side of a middle rising, is slanting, and exactly adapted to the pully of the bone of the arm. Across the middle of it, there is a small sinuosity, where, as well as in a small hollow on the internal side of it, the cartilage that lines the rest of its surface is wanting. Round the brims of this concavity the bone is rough, for the better fixing of the capsular ligament of the joint. Immediately below the olecranon, on the back-part of the ulna, the surface of the bone is flat. At the internal side of this there is a larger hollow surface, where the musculus anconæus is lodged; and the ridge at the inside of this gives rise to the musculus supinator radii brevis. Between the top of this ridge and the coronoid process, there is a semilunated smooth cavity, lined with cartilage, on which the round head of the radius revolves. Below the root of the coronoid process, this bone is scabrous and unequal, for the insertion of the brachialis internus muscle. On the outside of this, we observe a smooth concavity, where the flexor digitorum profundus takes its origin. The body of the ulna is triangular. The internal angle is very sharp, where the ligament that connects the two bones is fixed: The sides which make this angle, are flat and rough. At the distance of one-third of the length of the ulna from the top, in its fore-part, the medullary vessels enter the bone. The external side of this bone is smooth, and somewhat convex, and the angles at each edge of it are blunted. As this bone descends, it becomes gradually smaller; so that its lower end terminates in a little head, standing on a small neck: Towards the fore but outer part of which last there is an oblique ridge, that gives rise to the pronator radii quadratus. The head is round, smooth, and covered with a cartilage on its internal side, to be received into the semilunar cavity of the radius; while a styloid process rises from its outside, to which a strong ligament that is extended to the os cuneiforme and pisiforme of the wrist is fixed.

Between the back part of that internal smooth side and this process, there is a grove for the tendon of the extensor carpi ulnaris. On the fore-part of the root of the process, such another depression may be remarked, for the passage of the ulnar artery and nerve.

The end of the bone is smooth, and covered with a cartilage.

Between it and the bones of the wrist, a doubly concave movable cartilage is interposed; which is a continuation of the cartilage that covers the lower end of the radius, and is connected loosely to the root of the styloid process.

The ulna is articulated above with the lower end of the os humeri. There are corresponding depressions and prominences in these bones; thus, the fore-arm may be extended to nearly a straight line, and bent to a very acute angle; but, by the slanting position of the pully, the lower part of the fore arm is turned outwards in the extension, and inwards in the flexion *; and a very slight degree of rotation is likewise allowed in all positions, especially when the ligaments are most relaxed, by the fore-arm being in a middle degree of flexion. The ulna is also articulated with the radius and carpus.

Of the Radius.

The Radius, so called from its imagined resemblance to a spoke of a wheel, is placed at the inside of the fore-arm.

The humeral extremity of the bone is circular, and excavated for its articulation with the tubercle at the side of the pully of the os humeri: the half of the round circumference of the head next to the ulna is smooth, and covered with a cartilage, and is received into the semi-lunated cavity of that bone.

Below the head, the radius is much smaller; therefore this part is named its *cervix*.

At the external root of this neck, a tuberous process rises; into the outer part of which the tendon of the biceps flexor

* Winslow, Mémoires de l'Acad. des Sciences, 1722.

cubiti is inserted. From this, a ridge runs downwards and inwards, where the supinator radii brevis is inserted; and a little below, and behind this ridge, there is a rough scabrous surface, where the pronator radii teres is fixed.

The body of the radius is convex on its internal and posterior surfaces; but flat next to the ulna, for the origins of the muscles of the hand; and both terminate in a common sharp spine, to which the strong ligament extended betwixt the two bones of the fore-arm is fixed.

A little below the beginning of the plain surface, on its fore-part, where the flexor muscle of the last joint of the thumb takes its origin, the passage of the medullary vessels is seen slanting upwards. The radius becomes broader and flatter towards the carpal extremity, especially on its fore-part, where its pronator quadratus muscle is situated.

The carpal extremity of the radius is larger than the superior. Its back-part has a flat strong ridge in the middle, and fossæ on each side.

In a small groove immediately on the outside of the ridge, the tendon of the extensor tertii internodii pollicis plays.

In a large one beyond this, the tendons of the indicator and of the common extensor muscles of the fingers pass.

Contiguous to the ulna, there is a small depression made by the extensor minimi digiti.

On the inside of the ridge, there is a broad depression, which seems again subdivided, where the two tendons of the extensor carpi radialis are lodged.

The internal side of this end of the radius is also hollowed by the extensors of the first and second joint of the thumb; immediately above which, a little rough surface shews where the supinator radii longus is inserted.

The ridges at the sides of the grooves, in which the tendons play, have an annular ligament fixed to them, by which the several sheaths for the tendons are formed. The fore-part of this end of the radius is also depressed, where the flexors of the fingers and flexor carpi radialis pass.

The external side is formed into a semilunated smooth ca-

vity, lined with a cartilage, for receiving the lower end of the ulna.

The carpal extremity of the radius is extended into an oblong cavity; in the middle of which there is a small transverse rising, gently hollowed; while the rising itself is insinuated into the conjunction of the two bones of the wrist that are received into the cavity.

This joint is bounded on each side by the ligaments which pass from the styloid processes of the radius and ulna, to the wrist.

The bones of the fore-arm are firmly bound together by an interosseous ligament, from the surfaces of which various muscles take their rise between the radius and ulna. But this ligament is wanting near the upper end of the fore-arm, where the supinator radii brevis, and flexor digitorum profundus, are immediately connected *.

Both ends of the bones of the fore-arm are first cartilages, and then epiphyses, in children.

As the head of the radius receives the tubercle of the os humeri, it is not only bent and extended along with the ulna, but may be moved round its axis in any position: That this motion round its axis may be sufficiently extensive, the ligament of the articulation is extended farther down than ordinary on the neck of this bone, before it is connected to it; and it is very thin at its upper and lower part, but makes a firm ring in the middle.

There is a double articulation between the radius and ulna; for above, a tubercle of the radius plays in a socket of the ulna; whilst below, the radius gives the socket, and the ulna the tubercle: at the humeral extremity, the radius revolves round its axis, but at the carpal extremity, it moves in a sort of cycloid upon the round part of the ulna; and as the hand is articulated and firmly connected here with the radius, they must move together.

When the palm is turned uppermost, the radius performs the supination; when the back of the hand is above, it is said to be prone. The quickness and large extent of these two

* Weitbrecht, Syndesmolog. fig. 10, 11.

motions are assisted by the ulna, which can move with a kind of small rotation on the sloping sides of the pully. This lateral motion, though very inconsiderable in the joint itself, is conspicuous at the lower end of such a long bone; and the strong ligament connecting this lower end to the carpus, makes the hand more readily obey these motions. When we wish to move the hand in a circular manner, we increase it by the rotation of the os humeri; and we sometimes employ the spine and inferior extremities to make these motions of pronation or supination of the hand still more extensive.

According to Sir Astley Cooper, there are five species of dislocation of the elbow-joint.

1*st*, Both bones are dislocated backwards.
2*d*, Both are dislocated laterally.
3*d*, The ulna is dislocated separately from the radius.
4*th*, The radius alone is dislocated forwards.
5*th*, The radius is dislocated backwards.
The first of these is by far the most frequent.

The dislocations at the joint of the wrist, according to the same author, are of three kinds: 1*st*, Dislocation of both bones, which are thrown either backwards or forwards, according to the direction in which the force is applied. 2*d*, Dislocation of the radius only; the bone being thrown on the fore-part of the carpus. 3*d*, Dislocation of the ulna.

Of the Hand.

There is a great difference in the size of the hands of the male and female, and also even in the same sex in different nations; those of the Chinese and Esquimaux are small. The hand is concave in front, for the more conveniently holding different bodies, and convex behind, for the sake of strength.

The one-half of the hand is less moveable than the other, and is a sort of base for the other half, which may be extended backwards very little farther than to a straight line with the fore-arm, but can be considerably bent forwards.

The hand has been divided into the *carpus*, *metacarpus*, and *fingers*; among which last the thumb is reckoned.

The Carpus is composed of eight small bones; *os scaphoides*, *lunare*, *cuneiforme*, *pisiforme*, *trapezium*, *trapezoides*, *magnum*, *unciforme*.

The *scaphoides* is situated most internally of those that are articulated with the fore-arm.

The *lunare* is immediately on the outside of the former.

The *cuneiforme* is placed still more externally, but does not reach so high up as the other two.

The *pisiforme* stands forwards into the palm from the cuneiforme.

The *trapezium* is the first of the second row, and is situated betwixt the scaphoides and first joint of the thumb.

The *trapezoides* is immediately on the outside of the trapezium.

The *os magnum* is still more external.

The *unciforme* is farther to the side of the little finger.

Of the Os Scaphoides.

The Os Scaphoides is the largest of the eight except one. It is convex above, concave and oblong below, and bears a distant resemblance to a boat; hence its name. Its smooth convex surface is divided by a rough middle fossa, which runs obliquely across it. The upper largest division is articulated with the radius. Into the fossa the common ligament of the joint of the wrist is fixed; and the lower division is joined to the trapezium and trapezoides. The concavity receives more than a half of the round head of the os magnum. The external side of this hollow is formed into a semilunar plane, to be articulated with the following bone. The internal, posterior, and interior edges are rough, for fixing the ligaments that connect it to the surrounding bones.

Of the Os Lunare.

The Os Lunare has a smooth convex upper surface, by which it is articulated with the radius. The internal side, which gives the name to the bone, is in the form of a crescent, and is joined with the scaphoid; the lower surface is hollow, for receiving part of the head of the os magnum.

On the outside of this cavity is another smooth, narrow, oblong groove, for receiving the upper end of the os unciforme; on the outside of which, a small round convexity is found, for its connexion with the os cuneiforme. Between the great convexity above, and the first deep inferior cavity, there is a rough fossa, to which the circular ligament of the joint of the wrist is fixed.

Of the Os Cuneiforme.

The Os Cuneiforme is broader above, and towards the back of the hand, than it is below and forwards. The superior slightly convex surface is included in the joint of the wrist, being opposed to the lower end of the ulna. Below this the cuneiform bone has a rough fossa, wherein the ligament of the articulation of the wrist is fixed. On the internal side of this bone, where it is contiguous to the os lunare, it is smooth and slightly concave.

Its lower surface, where it is contiguous to the os unciforme, is oblong, and concave.

Near to the middle of its anterior surface a circular plane appears, for the attachment of the os pisiforme.

Of the Os Pisiforme.

The Os Pisiforme is almost spherical, except one circular plane, or slightly hollow surface, which is covered with cartilage, from which its whole rough body projects into the palm; having the tendon of the flexor carpi ulnaris, and a ligament from the styloid process of the ulna, fixed to its upper part; and the transverse ligament of the wrist, to its internal side: ligaments, extended to the unciforme bone, and to the os metacarpi of the little finger, are attached to its lower part: the abductor minimi digiti has its origin from its fore part; and, at the internal side of it, a small depression is formed, for the passage of the ulnar nerve.

Of the Os Trapezium.

The Os Trapezium has four unequal sides and angles in its

back-part, from which it has got its name. Above, its surface is smooth, slightly hollowed, and semicircular, for its conjunction with the os scaphoides. Its external side is an oblong concave square, for receiving the following bone.

The inferior surface is formed into a pulley, on which the first bone of the thumb is moved.

On the outer side of the external protuberance, a small oblong smooth surface is formed by the os metacarpi indicis.

The fore-part of the trapezium is prominent in the palm, and, near to the external side, has a sinuosity in it, for the tendon of the flexor carpi radialis; on the ligamentous sheath of which the tendon of the flexor tertii internodii pollicis plays: And still more externally the bone is scabrous, for the connection of the transverse ligament of the wrist. The abductor and flexor primi internodii pollicis have their origin from this part of the bone, and ligaments pass from it to the first bone of the thumb.

Of the Os Trapezoides.

The Os Trapezoides, so called from the irregular quadrangular figure of its back part, is the smallest bone of the wrist, except the pisiforme.

The figure of it is an irregular cube.

It has a small hollow surface above, by which it joins the scaphoides; a long convex one internally, where it is contiguous to the trapezium; a small external one, for its conjunction with the os magnum; and an inferior convex surface, the edges of which are, however, so much raised before and behind, as to form a sort of pulley, where it sustains the os metacarpi indicis.

Of the Os Magnum.

The Os Magnum, so called, because it is the largest bone of the carpus, is oblong, having four quadrangular sides, with a round upper end, and a triangular plain one below.

The round head is divided by a small rising, opposite to the connection of the os scaphoides and lunare, which toge-

ther form the cavity for receiving it. On the inside, a short plain surface joins the os magnum to the trapezoides.

On the outside, there is a long narrow concave surface, where it is contiguous to the os unciforme.

The lower end, which sustains the metacarpal bone of the middle finger, is triangular, slightly hollowed, and more prominent on the internal side than on the external, having a considerable oblong depression made on the advanced inside by the metacarpal bone of the fore-finger; and generally there is a small mark of the os metacarpi digiti annularis on its external side.

Of the Os Unciforme.

The Os Unciforme is named from a thin broad process that projects into the palm, and is hollow on its inside, for the passage of the tendons of the flexors of the fingers, and to this process also the transverse ligament is fixed, that binds down and defends these tendons. The flexor and abductor muscles of the little finger have part of their origin from it.

The upper plain surface is small, convex, and joined with the os lunare.

The internal side is long, and slightly convex, adapted to the contiguous os magnum.

The external surface is oblique, and irregularly convex, to be articulated with the cuneiform bone.

The lower end is divided into two concave surfaces; the external is joined to the metacarpal bone of the little finger, and the internal one to the metacarpal bone of the ring-finger.

In the description of the preceding eight bones, I have mentioned only those plain surfaces covered with cartilage, by which they are articulated to each other, or to other bones.

For the sake of additional strength, the surfaces of these bones are convex behind, and concave before; which concavity is increased by the os pisiforme, and the prominent processes of the os unciforme, and the trapezium: And these bones are bound together by a broad strong transverse ligament, which

also gives protection to the nerves, and tendons of the fingers. The substance of these bones is spongy and cellular, but strong in respect of their bulk.

The three first bones of the *carpus* are articulated with the cavity at the carpal ends of the bones of the fore-arm; so as to allow motion to all sides, and, by a quick succession of these motions, they may be moved in a circle. But as the joint is oblong, and therefore the two dimensions are unequal, no motion is allowed to the carpus round its axis, except during the pronation and supination of the hand.

The three bones of the superior row, are articulated in such a manner, with the bones of the inferior, as allows of motion, especially backwards and forwards; to the security and easiness of which the reception of the os magnum into the cavity formed by the scaphoides and lunare contributes considerably: the greater number of the muscles that move the wrist on the radius, being inserted beyond the conjunction of the first row of bones with the second, act equally on this articulation as they do on the former; and the joint formed with the radius being the most equally moved, the first effect of these muscles is on it; and the second row of the carpus is only moved afterwards., which contributes to extend the sphere of motion of the wrist.

The surfaces of articulation of the other bones are plain, firmly fixed by ligaments to each other, and scarcely allow of motion. All the bones of the carpus are in a cartilaginous state at the time of birth. On account of the number of tendons that pass upon the lower end of the fore-arm and the carpus, and of the numerous ligaments, the pain of sprains of the wrist is acute, and the parts take long time to recover their tone.

Of the Metacarpus.

The Metacarpus consists of four bones, which sustain the fingers. Each bone is long and round, with its ends larger than its body. The upper end or base is flat and oblong, without any considerable head or cavity; but is somewhat hollowed, for the articulation with the carpus; and

where these bones are contiguous to each other, they are flat, and also behind, for the more easy play of the tendons of the extensor muscle.

The anterior surface of these bodies is a little concave, especially in their middle: along which a sharp ridge stands out, which separates the musculi interossei placed on each side of these bones. Their lower ends are oblong, whose greatest extent is forwards from the axis of the bone.

At the fore part of each side of the root of each of these heads, there are one or two tubercles, for the ligaments that go from one metacarpal bone to another, and which prevent their disunion.

Around the heads, there is a rough ring for the insertion of the capsular ligaments of the first joints of the fingers; and both sides of these heads are flat, where they press on each other.

At the time of birth, these bones are cartilaginous at both ends, which afterwards become epiphyses.

The metacarpal bones are joined above to the ossa carpi, and to each other by nearly plain surfaces. The movements of these bones are therefore limited. The metacarpal bones are concave towards the palm of the hand, and their bases form the arch of the carpus.

The spaces between them lodge muscles, and their small motion makes them fit supporters for the fingers to play on.

The ossa metacarpi may thus be distinguished from each other. The os metacarpi indicis is generally the longest. Its base, which is articulated with the os trapezoides, is hollow in the middle.

The small ridge on the internal side of this oblong cavity is smaller than the one opposite to it, and is made flat on the side by the trapezium.

The exterior ridge is also smooth, and flat on its outside, for its conjunction with the os magnum; immediately below which there is a semicircular smooth flat surface for the articulation of this to the second metacarpal bone.

The back part of this base is flat, where the long head of the

extensor carpi radialis is inserted; and its fore part is prominent, for the insertion of the tendon of the flexor carpi radialis.

The external side of the body of this bone is more hollow than the internal. The tubercle at the internal root of its head is larger than the external. Its base is so firmly fixed to the bone it is connected with, that it has no motion.

The os metacarpi medii digiti is generally the second in length; but is often as long as the former; sometimes it is longer; and frequently it appears to equal the first only by the os magnum being farther advanced downwards than any other bone of the wrist.

Its base is a broad superficial cavity, slanting outwards; the internal posterior angle of which is so prominent, as to have the appearance of a process. The internal side of this base is plain, while its external side has two hollow circular surfaces, by which it is united to the third metacarpal bone, and between these surfaces there is a rough fossa, for the adhesion of a ligament. The two sides of this bone are almost equally flat; only the ridge on the fore part of the body inclines outwards. The tubercles at the fore part of the root of the head are equal.

The os metacarpi digiti annularis is shorter than the second metacarpal bone. Its base is semicircular and convex, for its conjunction with the os unciforme. On its internal side there are two smooth convexities, and a middle fossa, adapted to the second metacarpal bone. The external side has a triangular smooth concave surface to join it with the fourth one. The anterior ridge of its body inclines to the outer side. The tubercles near to the head are equal. The motion of this third metacarpal bone is greater than the motion of the second.

The os metacarpi minimi digiti is the smallest and sharpest. Its base is irregularly convex, and rises slanting outwards. Its internal side is exactly adapted to the third metacarpal bone. The external side is prominent where the extensor carpi ulnaris is inserted. This metacarpal bone is more move-

able than any other, and has a muscle adapted to that purpose, and it draws the third bone with it, when the palm of the hand is to be made hollow by its advancement forwards, and by the prominence of the thumb opposite to it.

Of the Thumb.

The THUMB, the antagonist of the fingers, is situated obliquely, in respect to them; and its bones are much thicker and stronger in proportion to their length.

The *first bone* of the thumb has its base adapted to the double pulley of the *trapezium*. Hence, this joint (which is thereby rendered more secure than those joints, where the head of the bone plays in an orbicular socket) may be moved in a circular direction. The edge at the fore part of this base is produced farther than any other part; and round the back part of the base a rough fossa may be seen, for the connection of the ligaments of this joint. The body and the head of this bone are of the same shape as the ossa metacarpi; but the body is shorter, and the head flatter, and the tubercles at the fore part of its root are larger.

The second bone of the thumb is somewhat like the third of the fingers, and has a large base formed into an oblong cavity, whose greatest length is from one side to the other. Round it there are several tubercles for the insertion of ligaments. Its body is convex, or a half-round behind; but flat before, for lodging the tendon of the long flexor of the thumb, which is tied down by ligamentous sheaths, that are fixed on each side to the angle at the edge of this flat surface. The lower end of this second bone has two lateral round protuberances, and a middle cavity, whose greatest extent of smooth surface is forwards.

On account of the strength of the lateral ligaments, oblong figure of the joint itself, and mobility of the first joint, the joint can be bent and extended only.

The bones of the fingers are arranged in three rows, named *phalanges*. All of them have half-round convex sur-

faces, covering the *aponeuroses* of the tendons of the *extensors*, *lumbricales*, and *interossei*, and placed directly backwards, for their greater strength. Their flat concave part is forwards, for lodging the tendons of the flexor muscles. The ligaments for keeping down these tendons are fixed to the angles between the convex and concave sides.

The bones of the first phalanx of the fingers are similar to the second bone of the thumb, only that the cavity in their base is not so oblong; nor is their motion on the metacarpal bones so much confined; for they can be moved laterally or circularly, but have no rotation, or a very small degree of it, round their axis.

Both extremities of this first phalanx are in a cartilaginous state at birth; and the upper one is afterwards affixed in the form of an *epiphyse*.

The base of the second bone of the fingers has two lateral cavities, and a middle protuberance; while the lower end has two lateral protuberances and a middle cavity: therefore it is joined at both ends in the same manner.

The third bone is similar to the second bone of the thumb, excepting in the general distinguishing marks; and therefore the second and third phalanges of the fingers can only be bent and extended.

The upper end of this third phalanx is cartilaginous in a child at birth; and is only an epiphyse after, till the full growth of the body.

The phalanges of the several fingers differ only as to magnitude. The bones of the middle finger being the longest and largest, those of the fore-finger come next in point of thickness, but not in length, for those of the ring-finger are a little longer. The little-finger has the smallest bones. As the longer fingers are applied to the middle largest periphery of such substances as are of a spherical figure, these are more securely held in the hand.

Dislocations of the *bones of the carpus* are very rare, owing to the strength and shortness, and number of ligaments, by which these bones are conjoined.

I do not recollect to have seen an instance of the simple dislocation at the carpus. Sir A. Cooper has made mention of such a dislocation accompanied by fracture of the radius. The fractured end of that bone was thrown backwards with the os scaphoides upon the carpus. The compound dislocation is by no means rare, in consequence of the bursting of muskets.

Dislocations *of the Fingers* are by no means rare, and especially the dislocation between the first and second phalanges.

The joints of the fingers and toes are very much swollen and distorted, in that disease which has been described by Dr Haygarth of Bath, as the *nodosity of the joints*. He observes, "They (the joints) feel as if they were enlargements of the bones. In this disorder the periosteum and ligaments are much affected." The disease, which is most frequent amongst old women, generally first shews itself in the joints of the fingers and toes, and sometimes in the wrists, ancles and knees, and more rarely in the shoulder or elbow joints.

These nodes are to the touch harder than the swelling occasioned by rheumatism, and do not occasion inflammation or fever, and there is no pink-coloured sediment in the urine, as often is observed in the rheumatic and gouty.

SECTION II.

OF THE INFERIOR EXTREMITIES.

The length and strength of the Inferior Extremities distinguish man from all the inferior animals; and have a reference to his erect position. The inferior extremities have commonly been divided into three parts, viz. the thigh, leg, and foot.

Of the Thigh-Bone.

The Thigh-Bone is the longest of the bones of the body, measuring in most men between fifteen and seventeen inches, and has generally been enumerated among the bones which, in their form, bear some resemblance to a

cylinder. This bone is placed obliquely in man, and the obliquity of the shaft of the bone has a reference to his erect position, and is owing to the greater breadth of the human pelvis, and the length of the neck of the thigh bone. Thus the lower extremity of the bone is brought more immediately under the pelvis, and proves a more firm column of support; for the axis of the bone coincides with the centre of gravity of the body; and hence our steps are not only more direct, but also more secure and quick.

If the knees had been at a greater distance from each other, we must have been obliged to describe some part of a circle with the trunk of our body in making a long step, and, when one leg was raised from the ground, our centre of gravity would have been too far from the base of the other, and we should consequently have been in hazard of falling; hence our steps would neither have been straight nor firm; nor would it have been possible to walk in a narrow path.

The form of the thigh-bone, and also the angle which the body of that bone makes with its head, are materially different in the rickety and healthy child. In the former, the head and neck of the bone form with its body a right angle, having yielded to the weight of the body. Hence, a ricketty child straddles in an unnatural manner in walking or running. But sometimes the angle is very acute; and I suspect that this case has been mistaken for a re-united fracture of the neck of the thigh-bone.

The head of this bone, which is the greater portion of a sphere, is unequally divided.

Towards its lower internal part, a round rough spongy pit is observable, where the *round* ligament is fixed.

In consequence of the obliquity of the thigh-bone, sufficient space is left for the external organs of generation; and round the root of the neck, where it rises from the bone, a rough ridge is found, where the capsular ligament of the articulation itself is connected.

The large unequal protuberance, called *trochanter major*, stands out from below the neck of the bone; the external con-

vex part of which is divided into three different surfaces; that on the fore-part is rough, for the insertion of the glutæus minimus; but the superior one into which the glutæus medius is inserted is smooth; and that behind is flat and smooth, as the tendon of the glutæus maximus passes over it.

The upper edge of this process to which the muscle called glutæus medius is fixed, is pointed, but farther forwards there are two depressions, into which the obturator internus and pyriformis muscles are inserted.

From the posterior prominent part of this great trochanter, a rough ridge runs backwards and downwards, into which the quadratus femoris is inserted.

In the deep hollow, at the internal upper side of this ridge, the obturator externus is implanted. More internally, a process, called *trochanter minor*, is placed, for the insertion of the psoas and iliacus internus muscles; and the pectineus is implanted into a rough hollow below its internal root.

The muscles inserted into these two processes are the principal instruments of the rotatory motion of the thigh.

On account of the tendons which are fixed into, or pass over the great trochanter, a bruise of this part is often attended with great pain and weakness of the limb, which are of long duration.

The body of the os femoris is convex before, and concave behind, even in the child at the period of birth. The fore part of the thigh-bone is somewhat flat, and also below. Its external surface is likewise flat below; on the posterior concave surface there is a ridge on its middle, called *linea aspera*, into which the triceps is inserted; and the short head of the biceps flexor crucis rises from it.

At the upper part of it the medullary vessels enter by a small hole that runs obliquely upwards; a little above which there is a rough fossa, for the insertion of the tendon of the glutæus maximus. The lower end of the linea aspera divides into two, which descend toward each side. The two vasti muscles in part arise from these ridges; and the long tendon of the triceps is fixed to the internal, by

means of part of the fascia aponeurotica of the thigh. Near to the beginning of the internal ridge it is discontinued, where the femoral artery passes through the aponeurosis.

Between these two rough lines, there is a flat surface, on which the large bloodvessels and nerves are placed; and near the end of each of these ridges a small smooth protuberance may often be remarked, where the two heads of the external gastrocnemius muscle take their rise, and where sesamoid bones are sometimes found *; and from the fore-part of the internal tubercle a strong ligament is extended to the inside of the tibia.

The lower end of the os femoris is expanded into two protuberances, called its *condyles;* between which a considerable cavity is found, especially at the back-part, in which the popliteal bloodvessels and nerves are situated. The internal condyle is longer than the external, which must happen from the oblique position of this bone, to give less obliquity to the leg.

Each of these processes seems to be divided in its plain smooth surface. The mark of division on the external is a notch, and on the internal a small protuberance. The fore-part of this division, on which the rotula moves, is like a pulley, which is higher on the external side; hence, the greater frequency of dislocations of the knee-pan outwardly. Behind, there are two oblong large heads, whose greatest extent is backwards, for the motion of the tibia; and from the rough cavity between them, but near to the base of the internal condyle, one of the conical ligaments of the knee takes its rise; a little above which, a rough protuberance gives insertion to the tendon of the triceps. On the back-part of the internal, a slight depression is made by the tendons of the gracilis and sartorius; and on the external, such another is formed by the biceps flexor cruris; behind which, a deep fossa is to be observed, where the popliteus muscle has its origin.

A strong round ligament extends between the external

* Vesal. lib. 1. cap. 28. & 30.

condyle of the thigh-bone and the upper part of the fibula. Round this lower end of the thigh-bone there are large holes, into which the ligaments of the joint are fixed, and bloodvessels pass to the internal substance of the bone.

All the processes of the femur are cartilaginous in new-born children, and afterwards become small apophyses, with large epiphyses.

The thigh-bone is articulated above with the acetabulum of the ossa innominata, within which it can be moved to every side; but is restrained in its motion outwards, by the high brim of the cavity, and by the round ligament.

The head of the thigh-bone may be dislocated in four different directions, backwards, or on the dorsum of the os ilium; or downwards and inwards, then the head of the bone is lodged on the foramen thyroideum, and may be felt in the upper and inner part of the thigh; or the head of the bone is forced upwards and forwards on the ossa pubis, where it may be felt above the level of the crural arch, and on the ilial side of the femoral artery and vein; or the head of the bone may be thrown backwards on the ischiatic notch.

The body of this bone has little or no rotatory motion, though the head moves commonly around its own axis, because the oblique progress of the neck and head from the bone is such, that the rotatory motion of the head can only bring the body of the bone forwards and backwards: Nor can the head be brought to a straight direction with its body; so far, however, as the head can move within the cavity backwards and forwards, the rest of the bone may have a partial rotation.

The os femoris is articulated below to the tibia and rotula.

There is considerable difficulty in distinguishing between a luxation and fracture of the neck of this bone.

Sir A. Cooper has observed, "The fracture of the neck of the thigh-bone may be confounded with the dislocation of the os femoris, upon the dorsum of the os ilii, into the ischiatic notch, and upon the pubes, as in all of these dislocations the limb is shorter. From the two former, it may be distinguished by the eversion of the foot, and by the mobility of the limb in fracture; and from the latter, by the ball of the os

femoris being felt in the groin, in the dislocation on the pubes, otherwise the eversion of the foot in both cases might lead to their being confounded."

"In order to distinguish these from fractures external to the capsular ligament, the surgeon will observe the very advanced age at which it usually occurs, the considerable shortening of the limb, the absence of the crepitus, if the limb be not drawn down and rotated, the slight cause by which it has been produced, and the little local and constitutional irritation it occasions *."

Different parts of the thigh-bone are frequently broken.

It may be observed respecting fractures in general, that those bones, which are most slightly covered, are most readily broken; and also, that there are some bones which, from their situation and office, are much exposed to fracture, as the long bones of the extremities, which serve as pillars or levers.

Fractures take place at the *middle, or towards the extremities of the bones.*

Fractures are *simple* or *complicated:* in the former, the injury is limited to the bone and periosteum; in the latter, the muscles and skin are injured. Sometimes bones are broken in several places.

Fractures are sometimes *incomplete;* and these rarely occur but in the young.

The surfaces of the pieces of the fractured bone touch each other *generally*, as where another bone serves to support the broken bone; the fibula, for instance, retains pieces of the broken tibia, in immediate contact.

Sometimes the *fractured pieces of bone touch each other only partially;* as, from the foot being turned round when the tibia has been fractured, the outer part of the circumference of the under piece of the broken bone may be applied to the inner part of the circumference of the upper piece.

If the muscles be fixed to both pieces of the broken bone, these are *not disunited;* but if they are only attached to one of these, as in fracture at the neck of the humerus, the teres

* Vid. p. 140. 1st Edition, of his treatise on fractures and dislocations of the joints.

major and latissimus dorsi draw the under portion upwards and backwards.

Many examples of ill set fractured thigh-bones are to be found in anatomical museums.

It is difficult to prevent the opposite portions of the fractured thigh-bone from crossing each other. The lower portion of the bone generally crosses the upper, which is occasioned by the contraction of the powerful muscles on the inner and back part of the thigh-bone. The weight of the limb has also a considerable influence in displacing the fractured extremities of the bones.

If the thigh-bone be broken below the lesser trochanter, the psoas magnus and iliacus internus muscles, draw upwards and forwards, the undermost piece against the skin, and rotate it a little outwards. When the thigh-bone is broken within the capsular ligament, the head of the bone is deprived of the blood it received through the medium of its neck, the periosteum, and the reflection of the capsular ligament, for the arteries of the round ligament of the thigh-bone form the only remaining medium by which blood can find its way to the head of the thigh-bone, when separated from the shaft of the bone; hence there is not the necessary ossification to re-unite the broken pieces of the bone; besides it is very difficult to keep the broken pieces of the bone in contact with each other. Boyer and Richerand have, however, affirmed, that a re-union of the broken pieces of the neck of the thigh-bone takes place, and several preparations were shewn to Mr Cross, on his visit to Paris *, to demonstrate the fact, which, however, did not satisfy Mr Cross, as, in those instances in which a union had taken place, a part of the fracture was beyond the limits of the capsular ligament.

Considering the difficulty of distiguishing a fracture within, from that without, the capsular ligament, it is not be wondered that mistakes should be committed as to the diagnoses of the particular fracture.

Dr Knox, a very acute and intelligent surgeon, gave me

* See account of his Trip to Paris in 1815.

the subjoined notes of three cases which he had occasion to see during his visit to the Continent, in which the above mistake had been committed.

"The Professor, to whose care the first of these was entrusted, joined SABATIER in opinion, that the circumstance of the sufferer having had a fall on the trochanter is of itself a strong presumption that a fracture in the neck of the thigh-bone had taken place; that his pupils were seldom mistaken as to the nature of the injury; that a union of the fractured pieces of the bone readily takes place, providing proper means be adopted to retain the fractured bones in immediate contact with each other; and, lastly, that fractures of the thigh-bone happening to persons under forty years of age, generally occur in the trochanters. But the very first case which happened in the practice of that Professor, proved, that a fracture *may take place in the trochanter in advanced life.* On the patient's admission into the hospital, he pronounced the case to be an instance of fracture of the neck of the thigh-bone, and applied with his own hands an improved apparatus for securing the perfect immobility and the extension of the limb. The patient, who was sixty years of age, died on the 15th day from the receipt of the injury. The dissection proved the fracture to be across the trochanters, *the head and neck of the bone being quite sound and untouched.* If the cure had been accomplished, this would have been considered to be a cure of a fracture of the neck of the thigh-bone. In another hospital of the same city, a stout muscular man, of fifty years of age, was supposed to have fractured the neck of his thigh-bone, and was treated accordingly. He died delirious about the fifth day; and, upon dissection, his case was found to be similar to the preceding.

"A third patient was brought into the hospital, for a fall he had met with on the trochanter major, which rendered him quite lame. The neck of the thigh-bone was supposed by the Professor and his pupils to have been broken. It was determined to apply the usual apparatus, as soon as he had recovered from some slight febrile symptoms, accompanied by delirium, under which he then laboured. The patient died

died on the 4th day; upon dissection, an inflammation of the arachnoid coat of the brain was discovered. *The thigh-bone was found in all respects sound.* The above cases shew the difficulty in distinguishing a fracture of the neck of the thigh-bone; and also, that we should not place implicit reliance on every case of supposed cure of the neck of the thigh-bone, that has been published.

In my lectures upon Surgery, I have always endeavoured to convince my pupils, that a fracture of the neck of the thigh-bone cannot be united: and have been led to adopt that opinion from dissection.

Sir Astley Cooper, when about to publish the appendix to his work on Fractures and Dislocations, proposed to me some queries respecting fracture of the neck of the thigh-bone; to which I returned the following answer:—"*Edinb. Feb.* 17. 1823.—My dear Sir Astley. In answer to your queries respecting fracture of the neck of the thigh-bone, I beg leave to inform you, that I have had an opportunity of examining only two cases after death; and in both of these, the broken ends of the neck of the bone were united by a substance somewhat like to ligament. I have seen several persons who had, during their lives, a fracture of the neck of the bone; but in all of them a bony re-union had not taken place.

"In the catalogue of the Museum which was bequeathed to the University by my Father, mention is made of the fracture of the neck of the thigh-bone, which had been re-united by bone. Upon examining this preparation with attention, it appears to me, that there has been no fracture, but a disease in the trochanter major; and that a number of osseous spiculæ have shot upwards within the capsular ligament, giving the appearance of an ill set fracture. Should you wish to have a drawing of this preparation, I shall have great pleasure in sending it to you. There is also a specimen in the Museum of a fracture of the thigh, about four lines beyond the insertion of the capsular ligament, at the root of the trochanter. Yours most truly,

'Alexr. Monro."

Dr Colles, Professor of Surgery in Dublin, and also Sir Astley Cooper, "are of opinion, that *a re-union of the broken pieces of the neck of the thigh-bone does not take place.*"

Sir Astley has stated it "to be a general principle, that the neck of the thigh-bone, when it is broken within the capsular ligament, and attended with the usual characters of that fracture, viz. occurring in advanced age, a limb shortened from one inch and a-half to two inches and a-half, accompanied, as it usually is, by an everted knee and foot, such fracture does not unite by an ossific process, but by means of a ligamentous substance passing from the capsular to the reflected ligament, and from bone to bone."

Sir A. Cooper, in his 2d edition, p. 127., says, "In all the examinations which I have made of transverse fractures of the cervix femoris, entirely within the capsular ligament, *I have never met with one in which an ossific union had taken place, or which did not admit of motion of one bone upon the other.* To deny its possibility, and to maintain that no exception to a general rule can take place, would be presumptuous, especially when we consider the varieties of direction in which a fracture may occur, and the degree of violence by which it may be produced; as, for example, when the fracture is through the head of the bone, and there is no separation of its fractured end, or when the bone is broken without the periosteum or reflected ligament being torn, or when it is broken obliquely, partly within and partly external to, the capsular ligament; but all I wish to be understood to say is, that if it ever does happen, it is a very rare occurrence, and that I have not yet met with a single example of it."

In fractures of this kind, the neck of the thigh-bone is absorbed to a greater or less degree, and portions of membranes of a ligamentous nature are generally found extending between the head of the bone and its neck, to the acetabulum, and to different parts of the surface of the capsular ligament. But I had occasion to examine an instance of fracture of the neck of the bone in which a partial union by ligamentous membranes had taken place; notwithstanding which, the patient,

a lad of eighteen years of age, could walk, and even run well. On opening the capsular ligament, I observed that the head had been detached from the neck of the bone by a fracture. The neck being considerably flattened, probably by having been rubbed against the acetabulum, was unequal on its surface, and covered in two or three different places by small white and very hard pieces of bone. The head of the bone, which was fixed in its place by the orbicular ligament, had not its usual rounded form.

Fractures without the capsular ligament may happen at any period of life, and these are often united by callus.

Of the Leg.

In the Leg there are two bones, the *tibia* and *fibula*.

There are national peculiarities as to the form of the legs. In the Negro, Hindoo, and American Indian, the tibia and fibula are more convex anteriorly than in the European; and the calves of the leg are very high, owing, probably, to their customs of resting the weight of the body on the lower limbs.

The ancients have described defects in the form of the legs in the Egyptians and Ethiopeans. Pallas has imputed the form of the legs of the Calmucks to their riding at a very early period of life: and even in this country, the legs are often bent outwards from riding.

Of the Tibia.

The Tibia, so called from its resemblance to an old musical pipe or flute, is a long thick triangular bone, situated at the internal part of the leg, and continued in almost a straight line from the thigh-bone.

The large upper end of the tibia is divided into two cavities, by a rough irregular protuberance, which is hollow at its most prominent part, as well as before and behind. The anterior crucial ligament is inserted into the middle cavity, and the depression behind receives the posterior ligament.

The two broad cavities at the sides of this protuberance are not of equal depth: the internal is oblong and deep, to

receive the internal condyle of the thigh-bone; while the external is more superficial, for the external condyle. In each of those two cavities of a recent subject, *a semilunar cartilage is placed*, which is thick at its convex edge, and becomes gradually thinner towards the concave or interior edge.

The middle of each of these cartilages is broad, and the ends of them turn narrower and thinner, as they approach the middle protuberance of the tibia. The thick convex edge of each cartilage is connected to the capsular and other ligaments of the joint; the narrow ends of the cartilages are fixed at the insertion of the strong cross ligament into the tibia: thus the surface of application between the bones forming the knee-joint is increased, and their semilunar cartilages at the head of the tibia afford, as it were, a variable socket for the condyles of the thigh-bone, that is (as Dr PALEY has well expressed it) "a concavity, the lines of which assume a different curvature in different inclinations of the bones."

The circumference of these cavities is rough and unequal, for the more firm connexion of the ligaments of the joint. Immediately below the edge, at its back-part, there are two rough protuberances: Into the internal, the tendon of the semimembranosus muscle is inserted; and a part of the cross ligament is fixed to the external. On the outside of this last tubercle, a smooth slightly-hollowed surface is formed by the action of the poplitæus muscle.

Below the fore-part of the upper end of the tibia, there is a considerable rough protuberance, to which the strong tendon, common to the four extensor muscles of the leg, is fixed.

On the internal side of this, there is a broad scabrous slightly-hollowed surface, to which the internal long ligament of the joint, the aponeurosis of the vastus internus, and the tendons of the semitendinosus, gracilis, and sartorius, are fixed.

The tibia ought not to be sawed through in an amputation above the insertion of these muscles, because the flexor muscles move, to a certain degree, the stump; and besides, it is necessary to leave sufficient space for the application of an artificial leg.

Below the external edge of the upper end of the tibia,

there is a circular flat surface, covered in a recent subject with cartilage, for the articulation of the fibula;—between which, and the anterior knob, there is a rough hollow, from which the tibialis anticus, and the extensor digitorum longus, take their origin.

From the smooth flat surface, a ridge runs obliquely downwards and inwards, from which a part of the solæus, tibialis posticus, and flexor digitorum longus, take their rise. At the inside of this ridge, an oblique plain surface is left, where the greatest part of the musculus poplitæus is inserted. The remaining body of the tibia is triangular. The anterior angle is very sharp, and is commonly called the *spine* or *skin*. This ridge is not straight; but turns first inwards, then outwards, and lastly, inwards again.

The internal side is smooth, but the external side is hollowed above by the tibialis anticus muscle, and below by the extensor digitorum longus and extensor pollicis longus. The two angles behind these sides are rounded; the posterior surface comprehended between them is flat. Some way above the middle of the bone, the internal angle terminates. Near to this, the passage of the medullary vessels is seen slanting obliquely downwards.

The lower end of the tibia is hollow, and a small protuberance rises from its middle. The internal side of this cavity, which is smooth, and in a recent subject is covered with cartilage, is prolonged into a considerable process, commonly named *malleolus internus;* the point of which is divided by a notch, and from it ligaments are sent out to the foot. The internal malleolus is situated more forwards than the internal condyle of the upper end of this bone; which is necessary to be remembered in reducing a fracture of the leg *.

In cases of violence, both bones of the leg are generally broken. The fracture is generally transverse, but sometimes oblique.

The degree of displacement of the broken pieces of the bone, depends, in some measure, upon the direction of the

* Winslow, Exposition Anatomique des Os secs. Sect. 265.

fracture, and the cause of the injury. In the oblique fracture, occasioned by a fall on the foot, the broken ends of the bones must pass each other; the upper portion projects downwards and forwards before the under piece, and the lower portion is drawn upwards and backwards. But if the fracture be transverse, there is often but a slight degree of displacement of the broken pieces; but every movement of the limb has a tendency to occasion a displacement; hence the necessity of the apparatus adapted to the cure.

The external side of the lower end of the tibia has a rough irregular semilunar cavity formed in it, for receiving the lower end of the fibula.

The posterior side has two lateral grooves, and a small middle protuberance. In the internal depression, the tendons of the musculus tibialis posticus and flexor digitorum longus are lodged; and in the external, the tendon of the flexor longus policis plays. From the middle protuberance, ligamentous sheaths go out, for tying down these tendons.

Both the ends of the tibia are cartilages at the birth, and become afterwards epiphyses.

Of the Fibula.

The Fibula is the small long bone, placed on the outside of the leg, opposite to the external angle of the tibia; the shape of it is irregularly triangular.

The head of the fibula has a superficial circular cavity on its inside, which, in a recent subject, is covered by cartilage, but being closely connected to the tibia by ligaments, it can be moved backwards and forwards only in a slight degree. This head is protuberant and rough on its outside, for the insertion of a ligament and the biceps flexor cruris; and, below the back-part of its internal side, there is a tubercle that gives rise to the strong tendinous part of the solæus muscle.

The body of this bone is a little crooked inwards and backwards.

The sharpest angle of the fibula is forwards; on each side of which, the bone is considerably, but unequally depressed.

The external surface of the fibula is depressed obliquely

from above downwards and backwards, by the two peronæi muscles.

Its internal surface is unequally divided into two narrow longitudinal planes, by an oblique ridge extended from the upper part of the anterior angle, to join with the lower end of the internal angle. To this ridge the ligament stretched between the two bones of the leg is connected.

The anterior of the two planes is very narrow above, where the extensor longus digitorum and extensor longus pollicis arise from it. The posterior plane is broad and hollow, giving origin to the larger share of the tibialis posticus. The internal angle of this bone has a tendinous membrane fixed to it, from which fibres of the flexor digitorum longus take their rise. The posterior surface of the fibula is made flat above by the solæus, and is hollowed below by the flexor pollicis longus. In the middle of this surface the canal for the medullary vessels may be seen slanting downwards.

The lower end of the fibula is extended into a spongy oblong head, on the inside of which is a convex, irregular, and frequently a scabrous surface, that is received by the external hollow of the tibia, and is firmly joined to it by a very thin intermediate cartilage and strong ligaments.

Below this, the fibula is stretched out into a smooth coronoid process, which is covered with cartilage on its internal side, where it is contiguous to the outside of the first bone of the foot, the astragalus, to secure the articulation. Hence luxations of the foot are very rare, and produced only by very great violence; and such luxations are frequently accompanied by a fracture of one of the malleoli. The luxation inwards, is more frequent than the luxation outwards, the malleolus internus being shorter than the malleolus externus. This process, named *malleolus externus*, being situated farther back than the internal malleolus, and in an oblique direction, obliges us naturally to turn the fore-part of the foot outwards*. From the lower internal part of the malleolus in-

* Winslow, Mémoires de l'Acad. des Sciences, 1722.

ternus, ligaments are extended to the astragalus, os calcis, and os naviculare; and, from its inside, short strong ones go out to the astragalus. On the back-part of it, a sinuosity is made by the tendons of the peronæi muscles. When the ligament extended over these tendons from the one side of the depression to the other is broken, stretched too much, or made weak by a sprain, the tendons frequently start forwards to the outside of the fibula.

The upper end of the fibula is united with the tibia by plain surfaces tipped with cartilage; and, at its lower end, the cartilage seems to glue the two bones together; not, however, so firmly in young people, but that the motion at the other end of such a long radius is very observable. In a subluxation of the foot, the external malleolus is generally broken, as the connection of the fibula to the tibia is very strong. In old subjects, the bones of the leg frequently grow together at their lower ends.

This bone affords origin and insertion to muscles, the direction of which may be a little altered on proper occasions, by its upper part shuffling backwards and forwards. It likewise renders the articulation of the foot more secure and firm.

The space between the tibia and fibula is filled up by an interosseous ligament, excepting at its upper part, where the tibialis anticus and solæus muscles are in immediate contact with each other. The fibula is very frequently fractured near to the ankle-joint. Dupuytren* has published a valuable memoir on such fractures, and their consequences. According to him, seven-tenths of such fractures occurred to the right leg, six-tenths from violent adductive movements of the foot, and only one-tenth from blows, or the passage of heavy bodies over the limb. The bone was generally fractured two inches from the lowest part of the malleolus externus; and, in these, the foot was displaced.

In the Museum there is an instance of fracture of the fibula, near to the ankle-joint, which shews, in a very striking man-

* Vide Annuaire Med. Chir. des Hopit. de Paris, 1819.

ner, the wonderful accommodation of bones to each other. The ankle-joint had been dislocated, and the fibula had been broken. The broken portion of the fibula had been completely detached, but had been re-united to the shaft of the bone, and was placed laterally, in respect to the ankle-joint. The end of the fibula, from which the broken piece had been detached, formed a new joint with the astragalus. The tibia had been dislocated forwards and inwards, and where the displaced end of the bone was in contact with the astragalus there also was a new joint.

Of the Rotula or Patella.

The ROTULA is the small flat bone situated at the fore-part of the joint of the knee. Its shape resembles the common figure of the heart, with its point downwards. The anterior convex of the rotula is pierced by a great number of holes, into which fibres of the strong ligament that is spread over it enter.

Behind, its surface is smooth, covered with cartilage, and divided by a middle convex ridge into two cavities, of which the external is largest; and both are exactly adapted to the pulley of the os femoris, on which they are placed in the most ordinary unstraining postures of the leg; but when the leg is much bent, the rotula descends far down on the condyles; and when the leg is fully extended, the rotula rises higher in its upper part than the pulley of the thigh-bone.

The plain smooth surface is surrounded by a rough prominent edge, to which the capsular ligament adheres: Below, the point of the bone is scabrous, where the strong tendinous ligament from the tubercle of the tibia is fixed.

The upper horizontal part of this bone, into which the tendons of the extensors of the leg are inserted, is flat. The substance of the rotula is cellular, with very thin external firm plates: But then these cells are so small, and such a quantity of bone is employed in their formation, that scarce any bone of its bulk is so strong. Besides, it is covered with the tendinous aponeurosis common to the extensor muscles of the leg. This bone is sometimes lacerated by the violent action of the

extensor muscles * of the leg. In such fracture, the rotula seems to give way, whilst the knee is in the middle state between flexion and extension; that is, whilst the middle of the rotula is supported on the rough line of the os femoris, as on a fulcrum; in which situation, the weight of the body and the muscles have the advantage of a lever to crack it across, although they were not sufficient, by straight traction, to draw its parts asunder. Sometimes this bone is broken in an oblique, and also, though rarely, in a longitudinal direction, by external violence. Owing to the considerable contusion, and great swelling on the knee, it is difficult to distinguish the precise nature of the injury; and, from the violence done, the patient sometimes sinks.

If the fracture be transverse, the strength of the knee generally bears a ratio to the distance of the broken portions of the knee-pan from each other,—a circumstance I some time ago saw strongly exemplified in the case of a gentleman who had broken both knee-pans. The cure was not equally perfect in both limbs: that of the right was the more incomplete; and hence that knee was so weak, that though he used a stick, he often fell upon it in going down a hill, or down stairs.

But there are some exceptions to the above observations, of which a very striking example presented itself to me the day after I had written the above lines. I shall give the case in the patient's own words:

"A stout man, between 30 and 40 years of age, broke the knee-pan of his left leg, by falling upon it two years ago. A bandage was applied, and he got well: the broken pieces were distant from each other about an inch; and, for six months after the injury, his leg was kept extended by a splint. After the splint was taken off, his leg was weak and stiff, and he was obliged to make his foot describe a semicircle in walking, and his toe often struck the ground. Fourteen months after the knee-pan had been broken, he fell down stairs, with his knee bent under him, but it never struck

* Paré, Liv. xv. chap. 22.

the ground; in consequence of which, the ligamentous substance which had united the pieces of the broken knee-pan was torn. He did not put on any bandage, but merely confined himself to bed for a few days, during which the broken pieces of the knee were again united, and are now at the distance of about $2\frac{1}{2}$ inches from each other. When he bends his knee, which gives him pain, there is a distinct crackling noise to be heard." He distinctly affirms, that *his knee is now as strong as that of the other limb.* He can readily walk up and down hill, or down stairs; and I saw him hop to a considerable distance without any uneasiness or inconvenience.

It is certainly remarkable, that the ligamentous membrane which had joined the broken pieces of the bone, had given way, and also that the knee should have been stronger after the fracture, though the fractured pieces of the knee-pan are now distant from each other about $2\frac{1}{2}$ inches.

At the ordinary time of birth, the rotula is entirely cartilaginous. From this circumstance, combined with the greater narrowness of the pelvis, the greater shortness of the necks of the thigh-bones, the want of solidity in the foot, arising from some of the bones which compose it being in a state of cartilage, the greater proportional bulk and weight of the head, and the weakness of the extensor muscles, it is evident that an infant cannot maintain its body in the erect posture.

Of the Movements of the Knee.

The principal motions are *Flexion* and *Extension.* In the former of these, the leg may be brought to a very acute angle with the thigh, by the condyles of the thigh-bones being round and made smooth far backwards. In performing this, the rotula is pulled down by the tibia. When the leg is to be extended, the rotula is drawn upwards, and consequently the tibia forwards, by the extensor muscles; which, by means of the protuberant joint, and of this thick bone, with its ligament, have in effect the chord, with which they act, fixed to the tibia at a considerable angle, and therefore act with advantage; but they are restrained from pulling the leg farther than to a straight line with the thigh, by the posterior crucial

ligament, that the body might be supported by a firm perpendicular column. When the joint is a little bent, the posterior ligament is relaxed; therefore this bone may be moved a little to either side, which is done by the motion of the external cavity backwards and forwards, the internal serving as a sort of axis *. Seeing, then, one part of the cross ligament is situated perpendicularly, and the posterior part is stretched obliquely from the internal condyle of the thigh outwards, that posterior part of the cross ligament prevents the leg from being turned at all inwards; but the lateral ligaments of this joint, which can yield little, prevent the leg from turning outwards to a considerable degree.

This rotation of the leg outwards, is of great use to us in crossing our legs, and turning our feet outwards; but this motion is limited, lest the bone should be dislocated. During the performance of these several movements, the part of the tibia that moves immediately on the condyles is only so much as is within the cartilaginous rings, which, being thicker externally, make the cavities of the tibia more horizontal, by raising their external side where the surface of the tibia slants downwards. By this means, the motions of this joint are more equal and steady. These cartilages change their places a little; they form a kind of moveable socket for the condyles of the thigh-bone, and likewise contribute to make the motions quicker and more extensive.

Excepting in cases of extreme debility, luxations of the knee-joint are very rare, on account of the very large surface of the bones forming the joint of the knee, and the many strong ligaments connecting them. In the hospital of this city, I had lately occasion to see an instance of this luxation, which had been occasioned by external violence. The ligaments of the knee were ruptured, and the tibia and fibula were dislocated outwards. The dislocation was removed, and the patient got well in a few weeks.

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* Winslow, Exposition Anatomique du corps humain, Traité des Os secs, sect. 976.

Of the Foot.

The Foot is divided into three parts, viz. *Tarsus*, *Metatarsus*, and *Toes**: In the description of which, the several surfaces shall be named, according to their natural situation, viz. the *broad* of the foot, shall be called superior; the sole, inferior; the side on which the great-toe is, internal; that where the little-toe is, external. There is much variety in the size of the foot; it is larger in the male than female. The bones of the foot somewhat resemble those of the hand, but they are stronger, larger, and more strongly joined, and less calculated for motion.

The tarsus consists of seven spongy bones; to-wit, the *astragalus*, *os calcis*, *naviculare*, *cuboides*, *cuneiforme externum*, *cuneiforme medium*, and *cuneiforme internum*.

The astragalus is the uppermost of these bones. The os calcis is below the astragalus, and is considerably prominent backwards beyond the other bones of the tarsus, to form the heel. The os naviculare is in the middle of the internal side of the tarsus. The os cuboides is the most external of the row of four bones at the fore-part of the tarsus. The os cuneiforme externum is placed at the inside of the cuboid. The cuneiforme medium is between the external and internal cuneiform bones, and the internal cuneiform is at the internal side of the foot.

In describing the bones, wherever a ridge is mentioned, without a particular use assigned, a ligament is understood to be fixed to it; or where a spongy rough cavity, depression or fossa is remarked, without naming its use, a ligament is inserted.

Of the Astragalus.

The upper part of the Astragalus is slightly hollowed in the middle, and adapted to the lower end of the tibia.

The head of this bone is internally flat and smooth, to play

* Dr Camper has recommended, that the shoes should be wider before, and more accurately adopted to the form of the foot, in order that the toes may have more full play, and may be less cramped.

on the internal malleolus, and also the larger external surface, which is articulated with the external malleolus. Round the base of this head there is a rough fossa; and, immediately before the head, as also below its internal smooth surface, we find a considerable rough cavity.

The lower surface of the astragalus is divided by an irregular deep rough fossa; which, at its internal end, is narrow, but gradually becomes broader, as it stretches obliquely outwards and forwards.

The smooth surface, covered with cartilage, behind this fossa, is large, oblong, extended in the same oblique situation with the fossa, and concave for its conjunction with the os calcis. The back-part of the edge of this cavity is produced into two sharp-pointed rough processes, between which is a depression made by the tendon of the flexor pollicis longus. The lower surface before the fossa is convex, and composed of three distinct smooth planes. The long one behind, and the exterior or shortest, are articulated with the heel-bone; while the internal, which is the most convex of the three, rests and moves upon a cartilaginous ligament, that is continued from the os calcis to the os scaphoides; without which ligament, the astragalus could not be sustained, but would be pressed out of its place by the great weight it supports; and the other bones of the tarsus would be separated.

The fore-part of this bone, which is smooth, is united to the os naviculare.

The astragalus is articulated in such a manner with the malleoli, that the foot may be bent and extended, but can be moved laterally only in a slight degree. When the foot is bent, so far as it commonly is when we stand, the head of the astragalus is sunk between the malleoli, and the ligaments are tense; it therefore cannot be moved sideways; but when the foot is extended, the astragalus can move a little to either side, and with a small rotation. By this contrivance, the foot is firm, when the weight of the body is to be supported on it; and when a foot is raised, we are at liberty to direct it more exactly to the place we intend next to step upon.

A considerable share of this bone is ossified in a new-born infant.

Of the Os Calcis.

The Os Calcis, the largest bone of the foot, projects considerably backwards to form the heel: The surface of which is rough behind, where the tendo Achillis is inserted into it; and above, it is hollow and spongy. Farther forwards, on the upper surface of the bone, there is an irregular oblong smooth convexity, adapted to the concavity at the back-part of the astragalus: And beyond this a narrow fossa is seen, which divides it from two small concave smooth surfaces, that are joined to the fore-part of the astragalus. Behind the posterior of these smooth surfaces, which is the larger, a small sinuosity is made by the tendon of the flexor digitorum longus; at the fore-part of which, a small rough protuberance appears, that gives rise to the musculus extensor digitorum brevis.

The external side of this bone is flat, with a superficial fossa running horizontally, in which the tendon of the musculus peronæus longus is lodged. The internal side of the heel-bone is hollowed, for lodging the origin of the massa carnea Jac. Sylvii, and for the safe passage of tendons, nerves, and arteries. Under the side of the internal smooth concavity, there is a groove for the tendon of the flexor pollicis longus; and from the thin protuberance on this internal side, the cartilaginous ligament that supports the astragalus, goes out to the os naviculare; on which ligament, and on the edge of this bone to which it is fixed, there is a groove for the tendon of the flexor digitorum profundus.

The lower surface of this bone is pressed flat at the back-part, by the weight of our bodies; and immediately before this plane, there are two tubercles, from the internal of which the musculus abductor pollicis, flexor digitorum sublimis, as also part of the aponeurosis plantaris, and of the abductor minimi digiti, have their origin; and the other part of the abductor minimi digiti and aponeurosis plantaris rise from the external.

Before these protuberances this bone is concave, for lodging the flexor muscles; and at its fore-part we may observe a rough depression, from which the ligament originates, that prevents this bone from being separated from the os cuboides.

The fore-part of the os calcis is oblong and circular at its upper external end, but is pointed below. This smooth surface is fitted to the os cuboides.

The very strong ligaments by which the os calcis and astragalus are connected, prevent these bones from being moved, in order to render the os calcis, which supports a considerable share of the weight of the body, firm.

A large share of the heel-bone is ossified at the ordinary time of birth, and the large knob appears afterwards, in form of an epiphyse.

Of the Os Naviculare.

The Os Naviculare is somewhat circular. The oblong concavity in the posterior part of this bone receives the anterior head of the astralagus. On the upper surface there is a rough fossa. Below, the os naviculare is very unequal and rough; but hollow for the safety of the muscles. On its inside there is a large knob, from which the abductor pollicis takes in part its origin, and the tendon of the tibialis posticus is inserted into it: And to it two remarkable ligaments are fixed; the first is the strong one, formerly mentioned, which supports the astragalus; the second is stretched from this bone obliquely across the foot, to the metatarsal bones of the middle toe, and of the toe next to the little one. On the outside of the os naviculare there is a semicircular smooth surface, where it is joined to the os cuboides. The fore-part of this bone is covered with cartilage, and is divided into three smooth planes, fitted to the three ossa cuneiformia.

The os naviculare and astragalus are like to a ball and socket, and the naviculare moves in all directions in turning the toes inwards, or in raising or depressing either side of the foot, but the motions are much limited by the ligaments which connect this to the other bones of the tarsus. A weak-

ness of these ligaments causes sometimes an unnatural turn of the fore-part of the foot inwards *.

The os naviculare is wholly cartilaginous in a new-born infant.

Of the Os Cuboides.

The Os Cuboides is a very irregular cube, which, behind, is moulded into an oblong unequal concavity, adapted to the fore-part of the os calcis. There is a small semicircular smooth cavity on the inner side of this bone, where it is joined to the os naviculare; immediately before which, an oblong smooth plane is made by the os cuneiforme externum. Below this, the bone is hollow and rough. On the internal side of the lower surface, a round protuberance and fossa are found, for the origin of the musculus adductor pollicis. On the external side of this same surface, there is a round knob, covered with cartilage; immediately before which, a smooth fossa may be observed, in which the tendon of the peronæus longus passes obliquely across the foot; and on the knob, the thin flat cartilage proper to this muscle plays; in place of which sometimes a bone is found: More externally than the knob, there is a rough hollow, for the strong ligaments stretched betwixt this bone and the os calcis. Before, the surface of the os cuboides is flat, smooth, and slightly divided into two planes, for sustaining the os metatarsi of the little toe, and of the toe next to it.

The form of the back-part of the os cuboides, and the ligaments connecting the joint there with the os calcis, concur in allowing little motion in this part.

If a weight bears on an arch, that arch is either supported at the sides, or these sides are joined together. It is in the latter way that this joint is secured.

When this ligament is sprained or torn, it generally brings on a tedious or incurable lameness.

The ossification of this bone is scarcely begun at birth.

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* The deformity in cases of club-foot is chiefly owing to the distortion of the os naviculare.

Of the Os Cuneiforme Externum.

The Os Cuneiforme Externum is broad and flat above, with long sides running obliquely downwards, and terminating in a sharp edge. The upper surface of this bone is an oblong square. The surface behind is nearly a triangle, but not complete at the inferior angle, and is joined to the os naviculare. The external side is an oblong square divided as it were by a diagonal; the upper half of it is smooth, for its conjunction with the os cuboides: The other is a scabrous hollow, and in its superior anterior angle, a small smooth impression is made by the os metatarsi of the toe next to the little one. The internal side of this bone is also quadrangular, with the fore-part of its edge made flat and smooth by the os metatarsi of the toe next to the great one, and the back-part is also flat and smooth where the os cuneiforme medium is contiguous to it. The fore-part of this bone is an oblong triangle, for sustaining the os metatarsi of the middle toe.

Of the Os Cuneiforme Medium.

The Os Cuneiforme Medium, *or* Minimum, is square above: its internal side has a flat smooth surface above and behind, for its conjunction with the following bone; with a small rough fossa below; and a considerable share of it is rough and hollow. The external side is smooth and a little hollowed, where it is contiguous to the last described bone. This bone is triangular behind, where it is articulated with the os naviculare; and it is also triangular at its fore part, where it is contiguous to the os metatarsi of the toe next to the great one.

Of the Os Cuneiforme Internum.

The Os Cuneiforme Maximum, *or* Internum, is situated more obliquely than the two other cuneiform bones. Besides, its broad thick part is placed below, and the small thin point is above and outwards; while its under broad surface is concave, for allowing a safe passage to the flexors of the great toe. The surface of this os cuneiforme be-

hind, where it is joined to the os naviculare, is hollow, smooth, and of a circular figure below, but pointed above. The external side consists of two smooth and flat surfaces, placed nearly at right angles with each other. With the posterior, that runs obliquely from below forwards and upwards, the os cuneiforme minimum is joined; and with the anterior, whose direction is longitudinal, the os metatarsi of the toe next to the great one is connected. The fore part of this bone is semilunar, but flat and smooth, for sustaining the os metatarsi of the great toe. The internal side is scabrous, with two remarkable tubercles below, from which the musculus abductor pollicis rises; and the tibialis anticus is inserted into its upper part.

The three cuneiform bodies are so strongly united by ligaments, that they possess very little motion; and they are cartilaginous in a fœtus of nine months.

These seven bones of the tarsus, when joined, are convex above, and concave below; thus the several muscles, tendons, and vessels, that lie in the sole of the foot, are safely lodged. And in the recent subject, their upper and lower surfaces are covered, and strongly united by other strong ligaments. Notwithstanding the many surfaces covered with cartilage, some of which are of the form of the very moveable articulations, no more motion is here allowed, than is sufficient to prevent too great a shock in walking, leaping, &c., by falling on too solid a base; and, in order that our foot may be accommodated to the surfaces, by becoming more or less hollow, or by raising or depressing either side of it. The movements of the astragalus, os calcis and naviculare, are not so limited. By these the foot is turned inwards and outwards, and when the internal edge is depressed, and its external edge elevated, the os naviculare glides upon the head of the astragalus.

The os naviculare and cuboides move a little upwards and downwards on the astragalus and os calcis.

Of the Metatarsus.

The METATARSUS is composed of five bones, which are of an irregular form. They may be distinguished from the metacarpal bones, by the following marks: 1. They are longer, thicker and stronger. 2. Their anterior round ends are not so broad, and are less in proportion to their bases. 3. Their bodies are sharper above, and flatter on the sides, with their inferior ridge inclined more to the outside. 4. The tubercles at the lower parts of the round head are larger.

The first or internal metatarsal bone is distinguished from the rest by its thickness. The one next to it is the longest, and with its sharp edge almost perpendicular. The others are shorter and more oblique, as their situation is more external. These general remarks, with the description I am now to give of each, may teach us to distinguish them from each other.

The os metatarsi pollicis, which sustains the greatest share of the weight of the body, is the thickest and strongest of these bones. Its base is oblong, irregularly concave, and of a semilunar figure, to be adapted to the os cuneiforme maximum. The inferior edge of this base is a little prominent and rough, where the tendon of the peronæus primus muscle is inserted. On its outside an oblique circular depression is made by the second metatarsal bone. Its round head has generally on its fore part a middle ridge, and two oblong cavities, for the ossa sesamoidea; and on the external side, a depression is made by the following bone.

The os metatarsi of the second toe is the longest of the five, with a triangular base, supported by the os cuneiforme medium, and the external side produced into a process; the end of which is an oblique smooth plane, joined to the os cuneiforme externum. There are two slight depressions, near to the internal edge of the base, made by the os cuneiforme maximum, between which is a rough cavity. On the outside of the base are two oblong smooth surfaces, for its articulation with the following bone; the superior smooth sur-

face being extended longitudinally, and the inferior perpendicularly; between which there is a rough fossa.

The os metatarsi of the middle toe is the second in length. Its base, supported by the os cuneiforme externum, is triangular, but slanting outwards, where it ends in a sharp-pointed little process; and the angle below is not completed.

The internal side of this base is adapted to the preceding bone; and the external side has also two smooth surfaces covered with cartilage, but of a different figure; for the upper one is concave, and, being round behind, turns smaller as it advances forwards.

The os metatarsi of the fourth toe, is nearly as long as the former, with a triangular slanting base joined to the os cuboides, and round at its external angle, having one hollow smooth surface on the outside: where it is pressed upon by the following bone, and two on the internal side, corresponding to the former bone; behind which is a long narrow surface impressed by the os cuneiforme externum.

The os metatarsi of the little toe, is the shortest, situated with its two flat sides above and below, and with the ridges laterally. The base of it, part of which rests on the os cuboides, is very large, tuberous, and produced into a long pointed process externally, where part of the abductor minimi digiti is fixed; and into its upper part the peronæus secundus is inserted. Its inside has a flat conoidal surface, where it is contiguous to the preceding bone.

In standing, the foot rests on the fore ends of these metatarsal bones, and the os calcis; and therefore it is necessary they should be strong, and should not be very moveable.

Of the Toes.

The bones of the Toes are very similar to those of the thumb and fingers: But their position, in respect of the other toes, is not oblique; and they are proportionally much stronger; for they sustain the force with which our bodies are pushed forwards by the foot behind, at every step we make; and the weight of the body is supported on these bones, when we stand on our tip-toes.

The three bones in each of the other four toes, are less than those of the fingers and smaller in proportion to their lengths: Their bases are much larger than their anterior ends: Their bodies are more narrow above and below, and flatter on the sides. The first phalanx is proportionally much longer than the bones of the second and third, which are very short.

Of the four, the toe next to the great one has the largest bones in all dimensions, and more externally the toes are less. The second and third bones of the little toe are sometimes intimately united.

The toes are of great use to us in walking; for, when the sole is raised, they bring our body, with its centre of gravity, perpendicular to the advanced foot.

The toes, thumb and fingers, have often been dislocated. As we can lay firm hold of the foot or hand, and of the dislocated bones, it may be supposed that the displaced bones may be readily replaced.

My Father in his Lectures used to observe, that he had seen several cases, in which "Surgeons of considerable general experience were foiled, not only where the bones had been for several days displaced, but even in recent dislocations; because they had not disengaged the bones, by drawing them asunder in opposite directions, before an attempt was made to extend the joint, not aware, that in such joints as are moved like a hinge, in two directions only, the lateral ligaments, which are thick and strong, *may fall across the neck of the displaced bone,* and render the reduction of its head very difficult." He used to cite the subsequent case in illustration of the above observations. "Miss M., æt. 7., fell in the street and dislocated the root of the thumb of her left hand, which passed on the back of the metacarpal bone. Three surgeons in succession attempted to reduce it, but in vain; and one of them pulled for ten minutes with such strength, that the sweat ran over his face. Next day I was called; one of the surgeons was of opinion that the bone could not be replaced; another attempt was, however, made, to remove the dislocation, by pulling a string which had been fixed to the dislocated bone, whilst the

metacarpal bone was secured, but it was as unsuccessful as the former.

" I observed that the surgeon pulled much downwards, by which the two bones were pressed closer together, instead of being disengaged; and, therefore, I requested, that the metacarpal bone should be held fast; then I drew the root of it backwards, and then extended it, having previously bent the last joint, in order to shorten the flexor muscle, and having also rolled the radius outwards, to shorten the long extensor muscles of the thumb." This had the desired effect.

Ossa Sesamoidea.

The OSSA SESAMOIDEA are of very different figures and sizes, and are generally said to resemble the seed of the *sesamum.* These bones vary in number in different individuals. They are found at the origins of the gastrocnemii muscles, at the first and second joints of the great toes, and at the joints of the thumbs and fingers; occasionally they are connected with the ossa pubis. Their number, figure, situation, and magnitude, are so uncertain that it were in vain to insist on the differences of each.

The sesamoid bones at the first joint of the great toe are the largest, are early formed, and are seldom wanting in an adult. These bones, by increasing the angle of insertion of the tendons of the flexor muscles, add considerably to the force of these muscles; and they may possibly tend to prevent the above mentioned tendons from being compressed by the weight of the body.

That the sesamoid bones are not formed in consequence of pressure, is evident, as in the fœtus a few months after conception, there are cartilages of a similar figure as the sesamoid bones.

SECTION III.

OF THE OS HYOIDES.

It yet remains to take notice of the *Os Hyoides*, which is not immediately (excepting in a very few rare cases) connected with any of the other bones.

The *Os Hyoides*, which is situated horizontally between the root of the tongue and the *Larynx*, bears some resemblance to the *Greek* letter *υ*, and has been described as consisting of a *Body*, *Cornua*, and *Appendices*.

The body or the middle broad part is convex before, and hollow behind. The convex fore part is divided into two, by a ridge, into the middle of which the *Mylo-hyoidei*, and into the sides the *Stylo-hyoidei* muscles are inserted. Above the ridge, the bone is horizontal, but pitted in the middle by the insertion of the two *Genio-hyoidei* muscles. Below the ridge it is convex, but made flat in the middle by the *Sterno-hyoidei*. The concavity behind faces backwards and downwards to receive the *Thyroid* cartilage, when the *Larynx* and the *os hyoides* are pulled towards each other by the action of the *Sterno-hyoidei* and *Hyo-thyroidei* muscles; and to its upper edge the ligamentous membranes of the *Epiglottis*, tongue, and *Thyroid* cartilage, are fixed.

The *Cornua* of the * *os hyoides* are stretched backwards from each side of its body, where often a small furrow points out the former separation; for in young subjects, the body and the *Cornua* are not one continued substance, as they come afterwards to be in adults. These *Cornua* are not always straight, nor of equal length. Their two plain surfaces stand obliquely sloping from above outwards and downwards. Into the external, the *Cerato-glossus* is inserted above, and the *Thyro-hyoideus* muscle below; and to the one behind, the ligamentous membrane of the tongue and *Larynx* adheres. Each of the *Cornua* becomes gradually smaller, as it is extended from the base; but ends in a round tubercle, from which a moveable cartilage stands out, which is connected to the upper process of the *Cartilago Thyroidea*.

I had occasion to see an instance, in which a small bone nearly an inch long, united the extremities of the styloid processes with the *cornua* of the *os hyoides*.

Where the body of the *os hyoides* joins on each side with its *Cornua*, a small styliform process, called *Appendix* †,

* Crura, Latera inferiora.

† Crura superiora, Latera superiora, Ossa graniformia.

rises upwards and backwards, into which the *Musculi Stylo-hyoidei alteri*, and part of the *Hyo-glossi* muscles are fixed. From each of them a ligament is sometimes extended to the *Styloid* process of the temporal bones, to keep the *os hyoides* from being drawn too much forwards or downwards. The ligaments connecting the *os hyoides*, and ascending *cornua* of the thyroid cartilage are sometimes, in persons of advanced life, converted into bone.

The substance of the *os hyoides* is cellular, but covered by a firm external plate. It is not articulated with any bone of the body, except by means of the muscles and ligaments mentioned.

The *os hyoides* serves as a lever upon which the muscles act in raising or depressing the tongue and *Larynx*, or in enlarging and diminishing the capacity of the *fauces*.

At birth, this bone is in a cartilaginous state; excepting a small point of bone in the middle of its body, and each of the *Cornua*. The *Appendices* frequently remain cartilaginous for many years.

The following observations, by the late Mr A. Burns, on the relative situation of the os hyoides, in respect to the other parts of the neck, merit attention.

" In the living person, in whom no part about the throat is called into action, and in whom the base of the skull is placed parallel to the horizon, the os hyoides can be felt through the integuments, situated about four finger-breadths behind the chin, and about a quarter of an inch lower in the throat than the margin of the jaw-bone. The upper prominent edge of the thyroid cartilage is traced, beginning about half an inch below the base of the hyoid bone, and is found, by following it with the finger, gradually sloping backward, and declining from the perpendicular as it descends. Between the os hyoides and thyroid cartilage, there is, on the fore-part of the throat, a little hollow or vacuity, but laterally no deficiency can be perceived. Just below the thyroid cartilage, a similar but smaller hollow is felt. About three or four lines lower than the inferior edge of the thyroid cartilage, the cricoid cartilage is discovered, forming a prominent

semicircle, resembling the body of the os hyoides. Next, by insinuating the finger and thumb between the margin of the sterno-mastoid muscles, we feel, just a little below the cricoid cartilage, a substance of a doughy consistence; but in the living subject, and in the healthy state of parts, its limits are by no means well defined. It is produced by, and marks the position of, the thyroid gland. Between the sterno-mastoid muscles, and below the thyroid gland, a hollow is felt, angular in its figure, containing the trachea: The point where we enter the windpipe, in performing the operation of tracheotomy.

"All these parts can be easily distinguished on the living body, and, consequently, the relation of the one to the other may be ascertained. In a full grown male, six finger-breadths will generally be found between the upper margin of the thyroid cartilage and the sternum. By dividing this into two equal portions, we define the superior border of the thyroid gland, and by allowing a single breadth of the finger, for the average breadth of the gland itself, a space capable of admitting two fingers is alone left below the gland and above the sternum *."

* Surgical Anatomy of the Head and Neck, p. 65, 66.

PART II.

OF THE CARTILAGES, SYNOVIAL APPARATUS, SYNOVIAL FLUID, AND LIGAMENTS.

CHAP. I.

OF CARTILAGE.

SECTION I.

GENERAL OBSERVATIONS ON CARTILAGE.

CARTILAGE may be distinguished from other animal substances, by its grey pearly or opal-like colour,—by the remarkable smoothness of its surface,—by its elasticity,—by its semi-pellucidity,—and by being much lighter than bone. There is a slight difference in the colour of the cartilages at different periods of life. In early life, it is more of a grey colour than in advanced life. Cartilage, when dried, becomes nearly transparent, and very brittle; when put into boiling water, it becomes more opaque, and shrinks. On account of the small size of the fibres of cartilage, it is very difficult to trace their course.

The cartilages, when macerated for some time in water, exhibit a fibrous structure. Cartilage forms a considerable share of those organs where it is necessary to combine flexibility with a certain degree of firmness, in order that the part may always preserve a certain form.

Cartilages are covered by a membrane called *Perichondrium*, which is somewhat similar in its office to the periosteum; serving to conduct the small vessels which enter into the substance of the cartilages.

The bloodvessels, nerves, and absorbent vessels of cartilage are so small as to elude observation; but there cannot be a doubt of their existence, of which there is the clearest evi-

dence from the phenomena of disease. Thus cartilages become, by pressure, thinner, or are sometimes absorbed.

The cartilages are sometimes converted into bone, especially in persons far advanced in life. The intervertebral cartilages, the cartilages which connect the ribs to the breast-bone, and sometimes also the articular cartilages of the hip and knee-joints, have been observed to be ossified; and also the ensiform cartilage of the breast-bone.

By scrofula, the cartilages become softer, and are sometimes absorbed; especially the intervertebral cartilages, and the articular cartilages of the hip and knee-joints; and, from gout, the articular cartilages of the fingers and toes have been often absorbed.

The articular and intervertebral cartilages are sometimes destroyed in part, or entirely, by ulceration; and especially in the scrofulous organic derangements of the bones. By the venereal poison, the epiglottis has sometimes been ulcerated or even destroyed.

Chemical Analysis of Cartilage.

As no experiments seem to have been performed upon human cartilage, I requested Dr JOHN DAVY to examine it. He did so, and favoured me with the following communication.

"In compliance with your request, I have made a few experiments on human cartilage; the results of which are such as might have been expected, and are agreeable to the conclusion generally drawn from Mr HATCHET's interesting researches, that cartilage is principally condensed albumen. That which I have examined, and which antomists call *obducent cartilage*, was apparently free from bone, and quite pure. A quantity of it was boiled in water, in a glass-vessel, for about an hour. The water was thus rendered cloudy in a slight degree. Infusion of nut-galls added to it produced a small precipitate; solution of corrosive sublimate had a similar effect; but acetate of lead occasioned a much more copious one. The cartilage was washed with fresh cold water, and again boiled for about three hours. The precipitate now produced by infusion of nut-galls and corrosive sublimate in

the water, was considerably less than in the first instance; and the effect of the acetate of lead was still more diminished. The cold sulphuric and muriatic acids acted on it very slowly; the former, after twenty-four hours, had acquired, from a small portion of cartilage that it had dissolved, a reddish-brown colour; and the latter, though most of the cartilage had disappeared, yet remained colourless. The nitric acid acted readily on it, and formed a yellow solution. Both the concentrated sulphuric and muriatic acid quickly dissolved it, when assisted by a gentle heat. The sulphuric solution was of a dark reddish-brown, and the muriatic was of a light reddish purple. A strong solution of potash also easily dissolved it. 100 grains of it were slowly, but completely dried. In this state it had the appearance of horn, being brittle and semitransparent. The loss it sustained was equal to 55 grains. The dried cartilage was heated to redness in a platina crucible: it swelled up very much, seemed to fuse, inflamed, and left a bulky charcoal. This charcoal incinerated, afforded about $\frac{1}{2}$ grain of earthy matter, which, as it dissolved in nitric acid, and was again precipitated by ammonia, appeared to be phosphate of lime. Hence it may be concluded that 100 parts of human cartilage consist of about

44.5	Albumen.
55.0	Water.
.5	Phosphate of Lime.
100.0	

" The effects of the acetate of lead and the infusion of nutgalls, as they were greatly diminished on the water in which the cartilage was a second time boiled, may be fairly attributed to a little adhering extraneous animal matter, or to the perichondrium itself, and not to the cartilage."

The cartilages have been divided by anatomists into two great classes, viz. into those which are *permanent*, and those which are *temporary* only.

The permanent cartilages are, the Articular, Interarticular, and Intervertebral, those of the External Ear, of the Nose, Eyelids, Larynx, and Windpipe.

Of the Articular, or Obducent Cartilages.

In order to render our movements easy, the articular surfaces of the bones are incrusted by cartilage,—a substance of a compact structure, and of an elastic nature; and, to prevent the bad effects of friction, these cartilages are constantly besmeared by a fluid called *Synovia.* Thus the articulating surfaces forming the joints, are constantly and accurately applied to each other, the effects of abrasion are obviated, and we are placed upon springs. Wherever it is necessary to combine considerable flexibility and strength, there are a number of joints at short distances from each other; so that, though the motion in each joint is comparatively small, the sum of the movements of the several joints is very considerable. The spine and feet afford most striking illustrations of this structure. In the former, by the number of joints, and intimate manner in which the component bones are united to each other, firmness, flexibility, and latitude of motion are combined There is no part of the human frame which is more wonderfully constructed than the foot. Owing to its peculiar mechanism, several very opposite properties are combined:—Considerable strength, which is requisite for the support of the weight of the body, and often of an additional burden,—flexibility, that it might be adapted to the inequalities of the surface of the ground,—elasticity, that the jar might be averted, to which we otherwise should have been exposed in dancing, running, jumping; and which also contributes to assist us in walking, or springing from the ground,—and protection to the muscles, bloodvessels, and nerves included in the sole, lest they should be pinched in our erect position.

These several properties are even more obvious in the construction of the foot of the horse; and especially the means by which the effect of the great weight of the animal's body upon the feet is counteracted. In addition to the elastic articular cartilages, there are, on the inner side of the hoof, five or six hundred very elastic laminæ, which grow from the coffin-bone. The frog of the foot is also a very elastic substance; and there is a quantity of fatty substance placed between the

flexor tendon and the frog;—thus the animal is placed, as it were, upon a series of springs.

Those cartilages which cover the extremities of the bones, and form the articulating surfaces, have been named *articulating* or *obducent* cartilages. They are remarkably smooth on the surface, lubricated by synovia, and of unequal thickness, being thickest towards the centre. The fibres of this kind of cartilage are remarkably small, and can be seen only after maceration in water for six or eight weeks; they may then be observed to be united at right angles in respect to the bone to which they are connected.

Of the Interarticular Cartilages.

The term *interarticular cartilage* is descriptive of the situation of these cartilages, some of which are moveable, but others are immoveable. The interarticular cartilages are harder than the former, and are thinner in the centre than towards their circumference. The interarticular cartilages tend to increase the surfaces of application of the articulating surfaces: they form a variable socket, the lines of which assume a different curvature in different inclinations of the bones; they adapt the surfaces of articulation to each other more accurately, in different positions of the joint, thereby adding to the security of the joint, and also to the sphere of its action: of this the articulation of the knee and of the underjaw affords a well-marked example, the interarticular substance of which moves with the condyle of the jaw, when it leaves its socket.

Of the Connecting Cartilages.

Contiguous bones, as the ossa innominata and os sacrum, the ossa pubis, the sternum, ribs and vertebræ, are united by cartilages. The intervertebral cartilages are of a very peculiar kind; being composed of an intermixture of cartilage and ligament. They partake of the properties of both. Thus the very

opposite properties, elasticity, flexibility and firmness, are combined *.

In the centre of these intervertebral cartilages there is a glutinous substance. My grandfather *discovered the mechanism of the Intervertebral Cartilages* of the true vertebræ. He has observed, in describing a body brought to him as being a non-descript fish,—" It consisted of two round plates of bone, with a flexible tough substance, about 1½ inch thick, interposed between them, and connecting them. No pressure could force the middle centrical part of the plates nearer: but, upon pressing any side of either of the plates, they approached each other, the intervening substance at the pressed part rising outwards into a convexity, while the opposite side, where the plates were separated, stretched considerably,—all these motions seeming to be performed upon a solid firm substance placed in the centre.

" Some of the young gentlemen who studied under my care, searched along the sea-shore, till, near to Granton, where a young whale was cast ashore a few years ago, they found such another body; and, seeing the vertebræ of the whale near to it, they were so obliging as to bring it, with one of the vertebræ, to me. Upon comparing the surfaces of the plates with the flat surfaces of the body of the vertebra, it was at first sight obvious, that the plates were no other than epiphyses separated from two adjacent vertebræ, and the intermediate substance was the cartilage interposed between the vertebræ. Upon cutting the soft ligamentous substance, its concentrical fibres shewed themselves; and it became softer gradually, till in the centre, where it had resisted all pressure formerly, it was altogether in a liquid form.

" The view of the play of these two plates, by means of the interposed ligament, with a liquor in the middle of it, served to explain to me the design of the structure of the cartilages between our vertebræ, which I was at a loss to understand before, though it is of the greatest advantage.

" The mucous part of this ligamentous cartilage in the hu-

* For a more particular account of these, see article *Spine*.

man body is placed near to the posterior part of the bodies of the vertebræ; and therefore is nearly in the middle between the anterior part of the bodies and the oblique processes of the vertebræ; so that, when we stand erect, each vertebra rests upon a fluid fulcrum or sort of pivot, the motion upon which to any side is easily and quickly performed; and, at the same time, is not too hasty or unequal: for the compressibility of the cartilages gradually increases from the liquid central incompressible part towards the circumference. Without this central pivot, in moving the spine from any reclined posture to the opposite one, particularly in moving forwards a spine that was reclined far back, there would often be the greatest danger of a most violent shock of one vertebra upon another, and indeed of all the parts of the body supported by them; whereas this contrivance allows a very gradual change of the centre of motion of each vertebra, accommodated to the bearing of the superincumbent weight in the different deflections of the spine from an erect posture, or in raising it to such a posture.

This liquid fulcrum, too, will bear off the great pressure which the vessels of the ligamento-cartilaginous substance would suffer in our erect posture, that might be of ill consequence; while the absorption of this liquor, increased by strong pressure, will serve to account, in part, for the difference of stature at night and in the morning *."

The knowledge of the mechanism of the joints of the spine † points out a frequent cause of a lateral curvature of the back-bone, viz. the too great extension and diminution of the elasticity of the connecting intervertebral ligaments of weak persons. The disadvantage resulting from the central inelastic part of the joint being over-extended, by which the vertebræ are left unsupported; and also the benefit to be derived from a weight of several pounds being carried upon the head in walking; during which exercise, the muscles of the spine keep closely together its component bones, and the elastic interver-

* Page 282. † Vide Edin. Med. Essays, vol. v.

tebral ligaments are kept in action, whereby they acquire the necessary strength in a few weeks *.

These cartilages are very compressible; and hence a tall young man loses sensibly of his height during the day, which he regains when in bed, upon the pressure of the superincumbent parts being removed.

On the same principle, the stoop of old age may be explained. On account of weakness of the muscles of the back, old people bend forwards, by which the fore-parts of the intervertebral cartilages, which are much compressed, become, on account of that pressure, much thinner.

The cartilages connecting the ribs to the breast-bone may be enumerated among this class of cartilages.

These cartilages may be resolved, by long maceration, into layers, of an oval figure, which are conjoined by a number of cross layers.

The cartilages which unite the ribs to the breast-bone, are powerful agents in expiration: being twisted during the elevation of the ribs, their elastic re-action tends to pull down the ribs.

Of the substance, like Cartilage, in which Bone is formed.

This substance, within which bone is formed, is composed of transverse and longitudinal fibres. These cartilages are of essential use: thus the body of the fœtus is more readily adapted to the form of the uterus of the mother; thus the sockets of the bones, which are cartilaginous, increase in proportion as the heads of the included bones, as in the hip-joint: hence there is less risk of dislocation.

In the skeleton of a child, there are also cartilages between the bodies of the bones and their epiphyses, and which generally disappear about the period of puberty *.

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* Mr Grant of Bath had the merit of introducing this improved method of treating deformity of the spine.

† Vide Haase, De Fabrica Cartilaginum; and Dr W. Hunter on the Structure of Cartilages, Lond. Phil. Trans.

SECTION II.

GENERAL OBSERVATIONS ON THE LIGAMENTS.

The ligaments are strong and flexible membranes, of a compact structure, and yellowish colour, which are composed of a number of fibres intimately interwoven with each other, and passing in different directions; and the greater number of these pass in the direct line between the parts which the ligament connects. The ligaments are of very different degrees of thickness, and generally may be resolved into two layers, the outer of which is considerably thicker than the inner.

The ligaments receive their supply of blood from those arteries which are in their immediate vicinity; and these arteries freely and frequently communicate with each other. These arteries are accompanied by corresponding veins, and also by lymphatic vessels. The ligaments possess but a very small share of elasticity and sensibility, though the nerves may be traced into their substance *.

That ligaments do not possess a large share of sensibility, was made manifest by the experiments of Haller. He laid bare the ligaments of an animal, and poured an acrid liquor into the joint, which seemed to give the animal but little pain. But, though ligaments, in their sound state, possess but a small share of sensibility, yet, when inflamed, they create great pain, and that inflammation sometimes proves fatal.

Hence when there is a necessity of cutting into the joints, in order to extract cartilaginous bodies, the air, which proves the cause of acute inflammation of serous membranes, should be carefully excluded, by drawing up the skin, and then cutting upon the cartilaginous body, and turning it out of the joint, and afterwards allowing the skin to slide back into its original place, so as to cover the hole in the capsular ligament. The incision ought afterwards to be well covered by dressing,

* Vide Monro on the Nervous System.

and rest and the horizontal posture recommended till the wound has healed.

In consequence of disease, the ligaments acquire a large share of sensibility. Thus in gout, the stones that form in the joints sometimes create great pain in working out.

The muscles which pass from one bone to another, and which cross over the joint when thrown into action, give additional security to these, by powerfully bringing into contact the articular surfaces of the bones. This fact is rendered quite obvious, by the weakness of the ankle-joints of puny children, and by subsequent deformity, the result of the bones having adapted themselves to their unnatural situation; and also by the additional bodily vigour and strength in the joints, which may be gained by regular exercise, especially in early life, when the bones are in a growing state, whereby they acquire such a form as admits of a still greater range of action.

The ligaments externally are rough, but internally smooth, and lubricated by synovia. There are different kinds of ligaments, which, on account of their shape or situation, have been arranged into six classes.

The *first* class comprehends the *capsular ligaments.* These ligaments serve for retaining the articular surfaces of the bones in contact, to which the tendons and muscles crossing the joints (especially when in a state of contraction, and when there is the greatest risk of the bones being displaced) essentially contribute.

The capsular ligaments are connected to the necks of the bones, or to that part where the bodies of the bones are joined with their epiphyses, and which, forming capsules including the joints, have been thence called *capsular ligaments.*

The capsular ligaments are not of an uniform extent nor of equal thickness. There are, in several, smaller fasciculi of ligamentous fibres which cross over the joints in different directions, which add considerably to their strength.

The extent of the capsular ligament is proportioned to the degree of motion performed: thus, at the shoulder-joint, the

capsular ligament is much longer than at the hip-joint, where the motions are much more limited.

The capsular ligaments are strengthened by tendons, with which they are in many cases intimately interwoven. Generally speaking, the capsular ligaments of the inferior extremities are stronger than those of the superior.

The capsular ligaments are thinner under the muscles which cross them, than elsewhere,—a sufficient proof that the joint derives security from the muscles which pass over it. Besides, there are irregular ligamentous bands dispersed over the capsular ligaments, which add considerably to their strength. But where the movements of the joints are more limited,—where flexion and extension only are performed, the capsular ligament is strengthened at its sides, by the addition of ligamentous bands, which have been commonly called Lateral Ligaments, and these are firmly interwoven with the periosteum. These pass between the bones of a joint, or from one part of a bone to another, and are always found in the joints like a hinge.

These lateral ligaments moderate, and in some measure regulate, the movements of the joints. The capsular ligaments are sometimes extremely relaxed, in consequence of the secretion of an unnatural quantity of synovia, which has been absorbed. The capsular ligament of some of the joints which possess a rotatory motion, as that of the shoulder-joint, is so loose as to admit of the head of the bone being placed upon the edge of the socket, or being subluxated, without tearing, and which generally can be effected only by considerable violence, though I have met with a few exceptions to this, in puny scrofulous children.

The *second* class includes those ligaments which *unite* the bones which *do not* move upon each other; as the os sacrum, and os innominatum.

The *third* class includes those ligaments which *supply the place of tendons*, and these possess a much greater share of elasticity than the other ligaments, and therefore save muscular power; such are the ligaments between the spinous processes of the vertebræ.

The *fourth* class comprehends such ligaments as *supply the place of bones*; as the ligaments which fill up the foramina obturatoria.

Under the same class, the ligaments called Interosseous, between the tibia and fibula, and the radius and ulna, which serve to unite the above bones, and to give origin to muscles, may perhaps be included. To save us from an unnecessary load, ligaments of this description are composed of distinct fasciculi joined together, and are a good deal involved with the periosteum.

The *fifth* class comprehends such ligaments *as form a socket, in which a moveable bone is lodged*; as the astragalus, which is lodged within the ligament stretched between the os calcis and os scaphoides.

The *sixth* class includes those ligaments which are *situated within the joints*, for the sake of additional security, and moderating and regulating the movements of the joints; as the round ligament of the hip-joint, and the crucial ligaments of the knee-joint. The reflections of the periosteum and pleura have been described as forming, within the thorax and abdomen, *ligaments* for retaining the liver, spleen, uterus, and bladder of urine, in their proper situation; and these constitute, according to some authors, *a distinct class* of ligaments.

The *seventh* class includes the elastic ligament, which is an antagonist to the muscles, by which parts are restored to their original situation, or supported in it. These form a part of some of the muscles. The head is supported by strong elastic ligaments appended to the muscles of the back, and the abdominal viscera of large animals, as those of the elephant, are supported by a similar substance.

There is still another class of ligaments, such as those which surround the sockets of the shoulder and hip joints, which are composed of tendinous, ligamentous and cartilaginous fibres, and in which the properties of all these different substances are combined. Thus these cavities are rendered deeper, and are protected from fracture during the sudden and violent movement of the limbs in certain directions.

Vide Weitbrecht, Syndesmologia, sive Historia Ligamentorum Corporis Humani, 4to; and Caldani's very beautiful Figures of the Ligaments. Monro on the Structure of Ligaments, in his Treatise on the Bursæ Mucosæ.

COMPARISON BETWEEN THE STRUCTURE OF THE CAPSULAR LIGAMENTS OF THE JOINTS AND BURSÆ, AND OF THE APPARATUS BY WHICH THE SYNOVIA OF THE JOINT IS SECRETED.

Before proceeding to describe the particular ligaments, it seems necessary to institute a comparison between the structure of the capsular ligaments of the joints and bursæ mucosæ, and to describe the synovial apparatus, and also the nature of that fluid. There is a striking resemblance between the structure of the capsular ligaments and bursæ.

1. The internal membrane of the ligaments of the joints, like that of the bursæ, is thin and dense.

2. It is connected to the external ligaments by the common cellular substance.

3. Between it and the bones, layers of cartilage, or the articular cartilages, are interposed.

4. At the sides of the joint, where it is not subjected to violent pressure and friction, the adipose substance is connected with the cellular membrane.

5. Within the cavities of the joints we observe masses of fat projecting, covered with similar bloodvessels, and with similar fimbriæ or fringes hanging from the edges.

6. In the knee we may observe the upper part of such a mass of fat, forming what has been called *the mucilaginous gland of the joint;* and the under part of it projecting into the bursa, behind the ligament which ties the patella to the tibia.

7. The liquor which lubricates the bursæ has the same colour, consistence, and properties, as that of the joints; and both, as I have found by experiment, are affected in the same manner by heat, mineral acids, and ardent spirits.

Immediately after an ox was killed, I opened the joints and large bursæ of the legs, and collected the liquors they contained. These were similar to each other in colour, smell,

taste, consistence, and weight; and gave the same degree of slipperiness when rubbed between the thumb and finger. When mixed with oil of vitriol, diluted with double its weight of water, both liquors became semi-opake, but were not coagulated. When two parts of these liquors were mixed with three parts of rectified spirits of wine, a portion, weighing nearly one-eighth part of the whole, was coagulated. When these liquors were brought to a boiling heat, they became less pellucid and more viscid; but the quantity of matter which clotted was very inconsiderable. When evaporated to dryness, they produced a tough crust, which weighed a small part only of the whole, and burnt in the flame of a candle nearly as a thin slice of horn does.

8. In some places the bursæ constantly communicate with the cavities of the joints; in others they generally do so: From which we may infer a sameness of structure.

9. To render the sameness of the structure of the bursæ and capsular ligaments still more evident, I shall next minutely describe the appearance of the several organs which may be supposed to furnish the lubricating liquor, which, in the joints, has been called *synovia;* and I shall be the more particular, because these parts have been generally very erroneously described, especially by late writers, and because no author has yet examined them with sufficient accuracy.

Dr Davy was so polite as to examine the synovia of the ox, and the following is the result of his experiments.

"The synovia you had the goodness to give me, resembles in physical properties the white of an egg, more than any other animal fluid I am acquainted with. It is very viscid, and at the same time remarkably soft, smooth, and slippery to the touch; so that it is admirably adapted for the office which it has to perform, of lubricating the joints. It has a slight taste of common salt, and a just perceptible smell. It froths when carelessly agitated, but does not when care is taken to prevent air being entangled by its parts.

"Its chemical properties are not so similar to those of the white of an egg as its physical ones. It readily mixes with

water. Heat renders it turbid, and occasions the coagulation of a small proportion of albumen. Diluted acids render it cloudy in a slight degree; but their effect is not equal to that of a boiling temperature. The latter not only produces an evident coagulation, but likewise destroys the peculiar viscidity of the fluid, which the acids do not affect. The sulphuric, muriatic, and nitric acids, in their concentrated state, first occasion a slight coagulation, and in a short time a perfect solution of the synovia, and a destruction of its viscidity. The sulphuric solution was of a light brownish yellow; the nitric of a light wine yellow; and the muriatic solution was colourless. Ammonia and potash appeared to have little effect on it. Corrosive sublimate, infusion of nut-galls, and acetate of lead, each produced a precipitate, and deprived the synovia of its viscidity. The precipitate by acetate of lead apparently exceeded in quantity that by corrosive sublimate, but was less than that which infusion of nut-galls afforded.

" From these results, synovia seems to contain albumen, gelatine and mucilage; and it also contains common salt, a small proportion of free alkali, and slight traces of phosphate of lime.

" I have endeavoured to ascertain the proportions of its constituent parts; but I have not been so successful as I could have wished, on account of the small quantity operated upon.

" 300 grains of it were immersed in boiling water, in a suitable glass vessel, for about ten minutes. The coagulum thus formed was separated, and dried till very brittle. It weighed 1.4 grains.

" The fluid, after the removal of the coagulated albumen, was almost transparent. When nearly evaporated to dryness, the little remaining fluid did not gelatinize on cooling. The dry residual matter weighed 3.5 grains.

" This residue and the albumen were heated to redness in a platina crucible. The charcoal produced was digested in water. The solution thus formed was evaporated to dryness, and small cubic crystals of common salt were obtained, that weighed $\frac{1}{10}$th of a grain. As they shewed no tendency to

deliquesce, though they rendered turmeric paper brown, it may be concluded that the quantity of alkali present was very small.

" The coal, after the separation of the common salt, was digested in dilute nitric acid. Ammonia afterwards added, occasioned a slight cloudiness, indicating a very minute proportion only of phosphate of lime.

" From the results of these experiments, 100 parts of synovia seem to contain—

98.3 water.
.93 gelatine and mucilage.
.53 albumen.
.23 common salt.
— traces of fixed alkali and phosphate of lime.

100.00"

Of the Source of the Synovia.

The synovia, as to its use, has been compared to oil. In machines made by human art a certain quantity of oil is applied where it is necessary, but in the joints of the human body the greater the necessity for a supply of synovia, the greater the quantity of it which is secreted.

The organs which pour out synovia are exposed to agitation, but are defended from injury when the joint is moved, and in different joints in different ways. Thus, in the case of the inferior extremity, the capsular ligament is drawn out by the round cord, and the synovial apparatus is pressed inwards by the head of the bone. In the knee joint the synovial apparatus is connected with the moveable patella, which in every flexion and extension of the joint is moved; and at the ankle joint the synovial apparatus is affected from being placed between two firm bones. The synovial apparatus may, however, be injured by external violence; thus, by a blow upon the trochanter major the head of the thigh-bone may be

drawn upwards with such force, that the synovial apparatus may be injured.

I shall first describe the structure of the fat, and afterwards that of the mucilaginous, glandular, or secerning organs.

It has been observed by Dr HAVERS *, that the marrow consists of globules; and, viewed through a magnifying glass, looks like a cluster of pearls.

MALPIGHI, and after him MORGAGNI, made the like observation concerning the fat elsewhere in the body: He was, however, doubtful whether the fatty globules were contained in a proper membrane †.

The globules in the fat have been supposed to be much larger than those of the marrow; and it has been, in the most positive manner, denied by the learned FR. GRUTZMACHER, who wrote on this subject in 1748, that the marrow and fat are inclosed with a peculiar membrane ‡: And, consistent with this, the common opinion, supported by the authority of WINSLOW ||, and by the still later authority of HEISTER, HALLER, LIEUTAUD, SABATIER, PLENCK, LEBER, &c. §, is,

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* CL. HAVERS, Ost. Nov. 1691, p. 197.

† M. MALPHIGHII Oper. Omn. Londin. 1686. De omento, pinguedine, et adiposis ductibus. An vero singuli adiposi globuli propria rursus investiantur pellicula oculus pertingere nequit.——MORGAGNI, Adv. Anat. 11. p. 16. Tota adiposa membrana ex sacculis constat; sacculi autem pinguiferis globulis, quasi glandulosis acinis, referti sunt.

‡ FR. GRUTZMACHER, De Ossium Medulla, Lips. 1748. sect. xii. In pinguedinis particula microscopio lustrata, corpuscula quidem in exteriori nimirum ejus parte invenimus, convexa et figura quadam irregulari prædita, ast longe majora iis quæ in medullæ exteriore interioreve substantia fuere observata.—— Sect xi. Pinguedo æque ac medulla nulla cingitur peculiari membrana.—Contextus ille cellularis, in quo oleum animale sive pinguedo continetur, sine ulla fere cellularum destructione inflari potest.

|| WINSLOW, Tr. des Tegum. sect iv. 69. Les bouchers gonflent la membrane adipeuse, &c.——70. Les interstices cellulaires sont comme autant de petits sacs remplis d'un suc huileux, que l'on apelle graisse.——Tr. des Os Frais. 74. La moelle est divisée en une quantité des vesicules ou cellules membraneuses, qui tapissent les cellules osseuses et communiquent toutes ensemble.

§ HEISTER, Comp. Anat. 1732, p. 73. sect. 20. De pinguedine.——HALLER, El. Phys. T. I. p. 33. Cellulæ adeo varia figuræ, adipi sunt pro loculis;—ab uno ad omnes via patet.—Figura utcunque rotunda est, cum ipse adeps sponte se in

that the fat is lodged in the cells of the common cellular membrane. And as the fat is commonly much wasted in dropsical constitutions, it has been taken for granted that when the fat was wasted the water occupied its place.

In 1762, the late Dr W. Hunter *, after taking notice of the general opinion, that the oil of the adipose membrane is lodged in the same cavities as the water of the anasarca, says, that he had long thought differently; "and that wherever there is fat, he apprehends that there is a glandular apparatus superadded to the reticular membrane, consisting of vesicles or bags for lodging the animal oil, as well as vessels fitted for its secretion." He then specifies his reasons for this opinion; and, in p. 36., proposes the following query: "From all these observations, may we not then reasonably conclude, that the oil of the cellular membrane is lodged in particular vesicles; and not, as the water of an anasarca, in the reticular interstices of parts?"

His arguments render his opinion extremely probable; but it is plain that he had not examined the structure with the microscope; by which alone the truth of it can be ascertained.

Long before Dr Hunter wrote, and, indeed, long before he began to study, my father used to observe †, and in his annual courses of lectures to demonstrate, that the marrow, viewed with the microscope, looked like a cluster of pearls. To this I added the observation, that after a good injection of the vessels, a vascular membrane could be shown surrounding each of the globules; and from which the marrow was beyond doubt secreted. I afterwards found, on applying the microscope in like manner to the fat, not only of man, but of

rotundas globulas colligat.——Lieutaud, Ess. Anat. 1766. p. 105.——Sabatier, Tr. d'Anat. 1781, t. I. p. 14. La moelle est composée de vesicules membraneuses qni communiquent toutes ensemble.—P. 15. De membranes que l'on peut distendre en souflant.—T. 3. p. 355. On sait que les cellules du tissu adipeux communiquent toutes les unes avec les autres.——Plenck, Pr. Lin. Anat. 1775, p. 176.

* Med. Obs. 1762, Art. ii. p. 33.

† See the first edition of his Osteology, 1726.

other animals, that it is every where contained in spherical bags, painted with vessels resembling in size, as well as in structure, those of the marrow; none of which, in diameter, exceed the six-hundredth part of an inch, nor are less than one-eight hundredth part of it. Holes in the sides of these bags, or ducts leading from them, and connecting them to each other, are not distinguishable, even with a microscope of high powers. In the hope of discovering more fully the texture of the adipose follicles, I have repeatedly examined with the microscope the texture of large steatoms; in which I was a good deal surprised to find the follicles not only as regularly shaped, but nearly as minute, as those of the fat in a sound state: Nay, I have often, in the same person, compared the fat of the sound cellular texture with that of a steatom, without being able to perceive any difference. I have, besides, tried the experiment of holding a thin portion of fat between my finger and thumb, dipped into water heated to above a hundred degrees of FAHRENHEIT's scale, and pressing it gently, without finding that the adipose follicles can by moderate pressure be emptied or made flat; and globules of oil are not distinguishable, even with the microscope, in the liquors taken from the abdomen, joints, and bursæ.

Hence some may perhaps infer, that there are no holes or ducts leading from them of considerable size. At the same time, from the oiliness which the surface of the skin, especially in the Negro, gets after exercise; from finding that the crusts, procured by evaporating these liquors to dryness, are inflammable; from the greasy feel of the omentum, or of the appendices epiploicæ of the colon even in a living animal; from the shortness of the omentum in man, compared with the great length of it in the quadruped, which we cannot account for in any other way than that the body of the one animal was intended to be erect, and that of the other horizontal; and, in the last place, as we scarcely can suppose that these fatty bodies in the joints and bursæ, and the omenta, serve merely as cushions for the defence of the secerning vessels, and therefore cannot point out any other material use for the omentum and these fatty bodies but that of furnishing

an oily matter for the purpose of lubricating,—I cannot see good grounds for doubting that the oil exudes from its follicles through invisible passages into the cavities of the abdomen, joints, and bursæ.

We next proceed to examine the nature of the fringes or fimbriæ, which we observe common to the fatty bodies of the joints and bursæ. These have been very generally supposed to be the ducts of glands lodged within, and protected by the masses of fat *. Yet, notwithstanding the appearance of accuracy in the description given of these glands, and the probability that these fringes are derived from some such origin, and that such bulky masses of fat as are found in the knee and in the bursa immediately under it, seem, at first sight, to be otherwise useless, I have not been able to discover the smallest vestige of any knotty, granulous, or glandular body lodged within these fatty masses in the joints of man or other animals. Nay, although we observe so many bloodvessels dispersed upon the membranes of these fatty bodies and upon the fimbriæ, and though we cannot doubt that these fimbriæ consist of ducts which contain a lubricating liquor, and though, in fact, when we press upon them we are sensible that it issues from them; yet their cavities and orifices are so minute, that I have not yet been able to get a distinct view of them, though I employed magnifying glasses.

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* Havers. Ost. Nov. 1691. p. 191. Glandulæ mucilaginosæ are red, pappy, &c.——Cowper, Expl. of Bidloo, Tab. 79. E. E. Mucilaginous glands of the knee. The ducts of these glands form a fringe, &c.——Morgagni, Adv. ii. Illud de structura earundum conglomeratarum ex Cowperi anatomia poteris, addere, &c.——Winslow, Exp. An. 1732. sect. ii. 68. Glandes mucilagineuses sont grenues, &c. en forme de grains.—184. Sont entrelardée d'une matiere graisseuse.—186. On distingue facilement la substance glanduleuse d'avec l'adipeuse, &c.——J. Weitbrecht, in Syndesmolog. calls these masses Adiposo-glandulosas.——Cheselden, 1740, p. 48. These glands are seated in fat.——Haller, El. Phys. t. ii. p. 366. Ex pinguibus globis, quæ in articulationibus pariter ut glandulæ, reperiuntur.——Plenck, Pr. Lin. Anat. 1775, p. 97. Glandulæ articulares. Sunt parvæ glandulæ, &c. p. 309. Glandulæ synoviales, &c.——Leber, Pr. Anat. 1778. p. 112. Constat synovia e mucilaginoso liquore glandularum articularium.——Sabatier, Tr. d'Anat. 1780, t. i. p. 9. Les glandes synoviales sont logées au milieu de masses graisseuses et rougeatres, &c.—Leurs canaux excreteurs representent des especes de franges, &c.

These fimbriæ seem, therefore, to be ducts like to those of the urethra, which prepare a mucilaginous liquor without the assistance of any knotty or glandular organ. While, by the pressure which the motion of the joints or tendons makes upon their sides, they throw out their liquor in greatest quantity when it is most needed, perhaps the secretion, as well as excretion, of the liquor, is promoted, as in the salivary glands, by motion; and as the extremities of these fringes hang loose into the cavity of the joint, their liquor cannot be pressed back into them by the motion of the joint.

Upon the whole, the synovia seems to be furnished by invisible exhalant arteries, by the ducts of the fimbriæ, and by oil exuding from the adipose follicles by passages not yet discovered. We may suppose these passages to be very minute, not only because they are not to be seen with the microscope, but because the oily matter is so well incorporated with the mucilaginous as not to be distinguishable, even with the microscope, in the form of globules.

As the fat seems to be mixed and incorporated with the mucilage in these sacs, it would, perhaps, be more proper to name them *vesicæ unguinosæ*, than bursæ mucosæ.

10. Having fully considered the structure of the bursæ and ligaments in a sound state, we shall next direct our attention to the effects upon them of use, accident, operation and disease; by which we shall be more fully convinced of the sameness of their structure and properties.

In old persons, I have frequently found a hole worn in the membrane of a bursa and ligament which were contiguous, particularly at the joint of the thigh-bone, by which a communication was opened between the cavity of a bursa and that of the ligament of a joint; yet no complaint of pain or stiffness of the joint had been made by persons during life. This could not well have happened if the liquor of the bursæ had been essentially different from that of the joints.

11. I have repeatedly observed an effusion of fluid into the cavities of the joints and of the bursæ from the same causes, or in consequence of the same diseases.

Thus, in rheumatic and gouty constitutions, the joints are often swelled; but when we attend narrowly to the seat of such swellings, we shall generally discover an effusion into the bursæ as well as into the cavities of the joints.

In like manner, in several scrophulous cases, I have observed the bursæ, especially at the wrists or ankles, stretched with a viscid fluid.

Dropsy of the joint of the knee, I have remarked, is a more common and a more curable disorder than I believe it is commonly supposed to be. I have kept an account of fifteen patients under this complaint, of whom eleven were completely cured by the use of leeches, blisters, and solution of sal plumbi in vinegar, and purgatives. In two more of the number, an effusion into the joint has continued for several years In the two remaining, the effusion was complicated with white swelling, and terminated in death.

In several cases of swelling of the knee with fluctuation, I have found that the fluid was lodged in the bursa behind the tendon of the extensors of the leg; and I have observed, that such tumors are apt, with time, to terminate in an imperfect suppuration, where some purulent matter is mixed with a viscid clear liquor.

When the tumor of the knee is small, we readily discover that the fluid is within the cavity of the joint; by observing, that when, after extending the leg in order to relax the tendon and ligament of the knee-pan, we press upon the soft swelling, the knee-pan is lifted up, and the capsular ligament of the knee, under the patella, at the sides of the strong ligament which ties it to the tibia, is protruded.

12. Cartilaginous bodies have been repeatedly observed by surgeons within the cavity of the joint of the knee; and a few such have been taken out after cutting into the cavity of the joint. Of this complaint I have met with various instances. In some the cartilaginous substance was fixed in its place; in others it slipped readily from one place of the cavity of the joint to another. In one case, three or four such moveable substances were distinguishable: in another, there were upwards of twenty such. These were so compact-

ed within the joint of the knee, that they impressed each other nearly in the same manner as concretions in the bladders of gall and urine are observed to do.

In like manner, I have several times observed small cartilaginous bodies form within the bursæ of the wrist after violent sprains: and in one case, which I examined with Mr Kilgour, surgeon at Ormistoun, I found a flat piece of moveable cartilage within the bursa of the glutæus maximus, to which the attention of the patient had been directed by the pain it frequently gave him.

In another very remarkable case, I found upwards of fifty cartilaginous bodies within the bursa mucosa which is placed behind the tendon of the flexor pollicis longus. The distention of the bursa by these cartilaginous bodies gave such intolerable pain to the patient, that I proposed to Mr Gibson, surgeon in Edinburgh, to puncture the bursa, and to press them out at the orifice; which was accordingly done by him.

The cartilaginous bodies expressed from the bursa, not only resembled those taken from the joints in their consistence, but in their internal structure; both, when cut, seeming to be composed of lamellæ.

The manner in which such bodies form within the joints has not been satisfactorily explained. Some have supposed that they were portions of the articulating cartilages beaten off by accident from the bones*: but from the appearance of the cartilaginous bodies extracted from the bursa, one-half of which had evidently small stalks or penduncles, and that some force was necessary to make them move to the place punctured; and that in two cases I have seen of cartilaginous bodies within the knee, in one of which an incision was made, these bodies were firmly fixed in their place; I apprehend, that all grow from or are nourished by penduncles; and it seems to me not only highly improbable that they can grow when the peduncle is broken by accident, but in one case, in which such a cartilaginous body was very moveable, I could

* Med. Ess. of Edin., Vol. iv. Art. xix.—Reimarus de Fungo Articul., p. 32.

not, after two years had elapsed, observe any difference either in its size or mobility.

13. I would, in the last place, observe, that the bursæ and ligaments correspond remarkably in having little sensibility in a sound state of the body, and in acquiring a great degree of sensibility by inflammation *.

That ligaments in a sound state have little sensibility, appears, in the first place, from the inconsiderable pain which often attends the relaxation of bones. In which case, however, it may be proved, from a variety of circumstances, that the ligaments are lacerated; but particularly because I found, by various experiments which I made on the human body, so long ago as the year 1754, and mentioned since that time in my lectures, that it is impossible, even in children, to dislocate the humerus, which is loosely articulated, without laceration of its capsular ligament, although the joint be previously relaxed by soaking it in tepid water.

This fact of the small sensibility of ligaments, is still more clearly proved by the experiments of Dr HALLER; who, in living animals, not only punctured the ligaments, but after doing so, poured oil of vitriol and other caustic substances into the cavities of the joints, without giving such pain to the animals as produced a sensible expression of it. To which we may add, that, in a few operations, in which, after extracting cartilaginous bodies from the cavity of the joint of the knee, the member was kept at rest and the wound carefully dressed, the wound closed without giving pain †.

On the other hand, we may not only observe violent pain

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* The nerves of the ligaments of most joints are so minute, that they cannot be traced by dissection; but, in some few places, nerves can be traced into ligaments, and particularly at the back part of the wrist, I find in all subjects a nerve adhering to the outer side of the ligament, which I have delineated in Tab. 26. of my work on the Structure and Functions of the Nervous System.

† See PECHLIN Obs. Ph. Med.—Dr D. MONRO on Dropsy, p. 170.—Two cartilaginous bodies, one of which is in my possession, were cut, in 1778, from the joint of the same knee, by W. INGLIS and Mr F. DEWAR, surgeons in Edinburgh.

produced in the joints, by white swelling, gout, and rheumatism, but where wounds have accidentally penetrated into the cavities of the joints, or been made with the intention of evacuating water, or of extracting such cartilaginous bodies, if the wound has not been properly closed, and the joint restrained from motion, a very considerable and painful swelling of the whole joint has ensued; which in some cases has terminated fatally, or, to save life, there has been a necessity of having recourse to the amputation of the limb *.

The bursæ, in the same way, have been unavoidably cut in many of the experiments of Dr HALLER and others on the tendons, and have appeared to be insensible. In some diseases, likewise, particularly in scrophula, I have observed them swelled without considerable pain. In other diseases, as in rheumatism, where greater inflammation is excited, we may frequently observe the bursæ at the wrists and ankles swelled with great pain; which is increased by pressing on these parts without bending the joints.

In the case I have described, where many cartilaginous bodies were found within the bursa of the flexor pollicis longus, when the bursa came to be much stretched, and probably slightly inflamed, the patient felt considerable pain when pressure was made on it; just as in the case of moveable cartilage within the knee, pain is often felt when the cartilage is lodged in certain places of the cavity of the joint. Generally, the patient is easiest when the cartilage can be felt at the sides of the joint; but in some cases, as in one I heard mentioned by Dr MIDDLETON in 1756, he is easiest when the cartilage is lodged under the patella, and kept from getting out of that situation by a bandage.

After extracting the cartilaginous bodies from the bursa, a very small seton was passed through it; as we took for granted, that if the puncture was allowed to close, the bursa would soon be again distended with fluid. The patient complained little in the time of passing the seton; but three days

* See Med. Ess. Vol. IV. Art. 20.—REIMARUS De Fungo Articul. p. 15, 16.—Dr D. MONRO on the Dropsy, p. 170.

thereafter we were obliged to withdraw it, on account of a violent inflammation; which, however, had the effect of creating the union of the opposite sides of the bursa, and thereby accomplishing a cure.

In the course of the present year, 1796, I was consulted by two patients with a considerable collection of synovia within the bursa which is behind the insertion of the extensors of the leg into the patella.

In both, after the application of discussing liquors and of blisters had been tried in vain, the liquor was drawn off by a lancet-shaped trocar passed obliquely, with the view of excluding the air.

It may be worth while to remark, that the liquor brought to a boiling heat was found to contain much more coagulable matter than the synovia does in a sound state. In one case, the operation was palliative only, and was not followed with inflammation or pain; but, in the other case, the whole knee inflamed violently, and suppurated, probably from the restlessness of the patient and admission of the air; so that the amputation of the limb became unavoidable.

It is therefore evident, that the bursæ and capsular ligaments of the joints resemble each other in their sensibility, as well as in their structure otherwise, and in their diseases *.

SECTION III.

OF THE PARTICULAR LIGAMENTS.

OF THE LIGAMENTS OF THE TRUNK OF THE BODY.

Ligaments of the Head.

The condyle of the under-jaw is retained in its place by a capsular ligament, which is connected with the temporal bone.

* All the observations contained in this section, excepting Dr Davy's analysis of the synovia of the ox, and the paragraph immediately following, ending with the word *injured*, have been derived from the 7th section of my Father's book on the Bursæ Mucosæ, published in Edinburgh, 1788.

There is also an internal lateral ligament extending between the posterior maxillary foramen of the under-jaw, and the petrous portion of the temporal bone.

Within this joint, there is an *inter-articular cartilage*, which is thinner in the centre than in the circumference; and to the edge of this the capsular ligament is fixed.

The skull is fixed to the cervical vertebræ, by a general capsular ligament, which surrounds the condyles.

There is a perpendicular ligament extending between the occipital bone, and upper part of the tooth-like process of the second cervical vertebra.

There are also two ligaments, one from each side of the tooth-like process, which have been named *lateral ligaments*, and which are inserted into the occipital bone before the condyles.

There is also a circular ligament arising from the edge of the foramen spinale, which is inserted into the edge of the foramen magnum.

Ligaments of the Vertebræ.

The tendons between the spinous and transverse processes of the vertebræ, serve the purpose of ligaments, and have been named from their situations.

A strong ligament, with fibres which follow a longitudinal direction, runs along the fore-parts of the vertebræ.

This ligament becomes broader the nearer it approaches the os sacrum, and serves to bind together and to defend the vertebræ.

The above ligament is formed by a number of shorter intervertebral ligamentous fibres.

The *theca vertebralis* is also lined by a ligament; it extends from the foramen magnum ossis occipitis, to the os sacrum.

There is an elastic yellow ligament passing between the spinous processes of the neck, which corresponding ligament is remarkably strong in the elephant, and in some birds, and tends by its elasticity to save muscular power.

There are ligaments which are peculiar to the atlas, and to the last lumbar vertebra.

There is an internal transverse ligament of the atlas, which serves to keep the processus dentatus in its place, and to prevent it from passing backwards, and compressing the spinal marrow.

There are *capsular ligaments* of the oblique processes of the lowest lumbar vertebræ, and which fix this bone to the sacrum, and also *transverse ligaments* for uniting the lowest lumbar vertebræ to the posterior and internal surfaces of the os ilium.

Ligaments of the Ribs.

The ribs are united before to the sternum or to cartilages *, and behind by *capsular ligaments* to the vertebræ.

The cartilages of the ribs are united to each other by a *perpendicular ligament.*

The heads of the ribs are retained in their places by *capsular ligaments*, by which they are joined to the vertebræ, and intervertebral cartilages.

The ribs are united by their tubercles to the transverse processes of the dorsal vertebræ, by *capsular ligaments.*

There are also *internal and external ligaments of the necks of the ribs.* The former originate from the superior margin of the neck of the ribs, and are fixed into the inferior surfaces of the transverse processes of the dorsal vertebræ immediately above; and the latter, which arise from the upper margin of the necks of the ribs, are inserted into the external margin of the inferior oblique process of the vertebræ above.

Ligaments of the Breast-Bone.

There is a thick ligamentous sheath which covers the breast-bone, the fibres of which may be observed passing in different directions.

There are also ligaments which arise from the cartilages of the seventh rib, and are fixed into the ensiform cartilage.

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* In pages 111 and 112, the reader will find a full account of the manner in which the cartilages of the ribs are connected to the breast-bone.

SECTION IV.

LIGAMENTS OF THE SUPERIOR EXTREMITY.

LIGAMENTS OF THE CLAVICLE, SCAPULA, AND SHOULDER-JOINT.

Front View.

The ligaments of the extremities of the body merit the most particular attention of the surgeon, not only on account of the injuries to which they are exposed from being wounded, sprained, or lacerated, but also as they are liable to suffer from peculiar organic derangements. It has been already observed, that, when a bone has been dislocated, the ligaments are generally torn; and hence, that only a surgeon who possesses an accurate knowledge of the structure of the ligaments, is capable of treating judiciously such an accident.

There are a number of ligamentous fibres which inclose the capsular ligament which connects the clavicle to the breast-bone, and within that joint there is an *inter-articular cartilage*, like to that of the under-jaw. This cartilage is placed obliquely, with its upper part directed inwards, and its lower outwards towards the first rib.

There is a ligament which passes across the sternum, from one clavicle to the other, which adheres to the capsular ligament, and also to the uppermost part of the breast-bones, and tends to fix the collar-bones intimately to each other.

There is a flat and short ligament, *of a rhomboidal figure*, covered by the subclavian muscle, which extends between the under surface of the clavicle, at no great distance from its neck, to the cartilage of the first rib.

There is a ligament, called by Caldani *bicorne*, which arises from the coracoid process of the scapula, and ascends obliquely; it consists of two parts; the one of which is fixed into the inferior part of the clavicle near to the rhomboidal ligament; the other part of it is fixed into the first rib, under the tendon of the subclavian muscle.

There are two thin ligaments (between which there is a bursa mucosa), which are stretched between the coracoid process of the scapula, and the middle and under part of the clavicle, and between these ligaments and the ligamentum bicorne, the subclavian muscle is placed.

In this front view, the anterior proper ligament of the scapula is seen, passing between the coracoid process of the scapula and the acromion scapulæ.

The capsular ligament of the shoulder-joint is fixed by its upper edge to the glenoid cavity of the scapula, and by its lower part to the neck of the os humeri, excepting between the two tubercles. This ligament is of an oblong form, and rather thinner on its inner part than elsewhere, and is made considerably stronger by the tendons of the muscles of the humerus, viz. by those of the sub-scapularis, infra-spinatus, supra-spinatus and teres minor, and also at its upper and fore part by ligamentous fibres, which, originating from the outer edge of the coracoid process of the scapula, pass to the larger tubercle at the head of the humerus. On removing the capsular ligament, we meet with a thin serous shut sac, in this as in other joints, which is formed by the Synovial Membrane. This membrane lines the capsular ligament, and is reflected over the articular cartilages; and it also lines, for the space of about an inch, the groove for the long head of the biceps flexor cubiti, and then passes over the tendon of that muscle.

The tendon of the long head of the biceps passes through the joint of the os humeri, and is confined within the groove in the os humeri situated between its tubercles, by a ligamentous sheath. The tendon of the biceps muscle gives additional strength to the upper part of the joint. On account of the length of the capsular ligament of the os humeri the movements at the shoulder-joint are very extensive, and generally combined with those of the shoulder.

Back View.

The proper posterior ligament of the scapula is flat and compact, and stretched across the semilunar notch of that bone, and forms that notch into an aperture for the superior and posterior bloodvessels and nerves of the scapula.

Sometimes this ligament is double.

Anatomists have supposed that this hole is covered by ligament, in order to prevent the vessels which pass through it, being injured by friction during the movements of the scapula.

There is a ligament, somewhat of *a conical figure*, and hence called *conoid*, which is in part connected with the last named ligament, and by the summit of the cone with the coracoid process of the scapula, and which is fixed near to the junction of the clavicle with the scapula.

Upon cutting into the capsular ligament of the shoulder-joint, it is found to be of unequal thickness: it is much thinner below than elsewhere; and, besides, in that situation, it is not strengthened by the tendons of the neighbouring muscles.

Ligaments of the Elbow-Joint.

The capsular ligament at the *elbow-joint* is much less extensive, than that at the shoulder-joint: it is connected with the lower end of the os humeri, and fixed around the edge of the articular surface of the ulna, and also to the coronary ligament of the radius.

On each side of the capsular ligaments there are *lateral ligaments*, the internal, or *humero-ulnar*, passing between the internal condyle of the os humeri, and the coronoid process of the ulna, and the external, or *humero-radial*, which is larger than the other, extending between the external condyle of the os humeri, and the accessory ligament.

Besides these lateral ligaments, there are a few scattered ligamentous fibres passing across the capsular ligament, in different directions, especially in the posterior part of the joint. Under these ligaments, the synovial membrane is placed. This joint only admits of flexion and extension: when the joint is bent, the lateral ligaments are relaxed; when, on the other hand, the joint is extended, the lateral ligaments are put on the stretch, and also the capsular ligament; and it may not be improper to add, that, in this position, this joint is most frequently dislocated by a fall, the hands being stretch-

ed out, to prevent the head striking the ground; in which case, the fore-arm slips behind the os humeri.

There is an *annular ligament*, which encircles the neck of the radius, and is fixed to the opposite sides of the semilunar cavity of the ulna. By this ligament, the radius is fixed down, during the pronation and supination of the hand.

There are a number of *additional ligamentous fibres* which pass over the capsular ligament, in different directions, which have been named *accessory ligaments.*

Sir A. Cooper has described "a band of ligamentous fibres crossing from the side of the coronoid process to the olecranon, and upon the radial side of the ulna, the upper portion of the coronary ligament of the radius passing from the side to the olecranon towards the neck of the radius. If the olecranon be broken off, and these ligamentous fibres be left entire, the olecranon will remain still united to the ulna, by means of these ligamentous productions, which I should not have noticed, but for their influence on fractures of this bone."

This joint is much strengthened by the tendons of the muscles passing over the joint.

Ligaments between the Radius and Ulna.

There is a strong *ligamentous membrane*, extending between the sharp ridges of the radius and ulna, the fibres of which extend obliquely downwards and inwards, which is called, on account of its situation, Interosseous Ligament.

This ligament is perforated in several places by bloodvessels, and there is a large opening at the upper part of it, which is filled by muscles.

This ligament not only binds together the radius and ulna, and limits the rotation of the radius, but also gives origin to many muscular fibres.

There is a capsular ligament which incloses the carpal end of the ulna, which arises from the edges of the semilunar cavity at the carpal end of the ulna.

Ligaments between the Fore-Arm and Wrist.

There is a capsular ligament extending between the mar-

gin of the glenoid cavity of the radius, and the cartilaginous edges of the os scaphoides, lunare, and cuneiforme.

There are two lateral ligaments, one placed between the styloid process of the radius, and the os naviculare, and the other, between the styloid process of the ulna, and the cuneiform and pisiform bones.

There is also an *internal mucous ligament* within the joint, which extends between the two first bones of the carpus, and the radius.

The joint, at the wrist, is strengthened by the tendons of the muscles fixed near to it, and also by the tendinous membranes, which fix down the tendons of the flexor and extensor muscles of the fingers.

Ligaments of the Carpus.

All the bones of the carpus are connected, being lined by a continuous synovial membrane.

The ligaments called *annular*, formed by the aponeurosis of the muscles, have been already described.

The bones of the carpus are firmly united before and behind, by ligamentous fibres; those on the back of the hand are the strongest.

There is a capsular ligament between the upper and under rows of bones which compose the carpus, which is strengthened by a great number of short ligamentous fibres, which cross the capsular ligament in different directions, and have been called *oblique*, *transverse*, and *perpendicular ligaments.*

The os pisiforme is detached from the other bones of the carpus: it lies on a concave surface of the cuneiform bone, and has its proper synovial membrane and proper ligaments: it is also fixed in its place by the abductor muscle of the little finger.

Ligaments between the Carpal and Metacarpal Bones.

The second row of the carpal bones is united to the neighbouring bones by capsular ligaments; and there are various additional ligamentous fibres, which have been named *oblique*, or *straight* ligaments, from the direction of their fibres.

Articular Ligaments of the Metacarpal Bones.

There are capsular or articular, and also *lateral ligaments*, placed at the sides of these joints, for the sake of additional security.

There are also ligaments extending between the bases of the metacarpal bones, which are placed transversely, and fix these bones firmly to each other; and which have been named *palmar* and *dorsal ligaments.*

There are also interosseous ligaments at the heads of the metacarpal bones, which in the palm of the hand are transverse, and fix the heads of these bones to each other.

The joints of the metacarpus are rendered more secure before, by the sheaths for the tendons of the flexor muscles, and behind, by the tendons of the extensor muscles.

Ligaments for Retaining the Tendons of the Muscles of the Hand, Fingers, and Thumb.

There are vaginal ligaments, lined with bursæ muscosæ, which inclose the tendons of the flexor digitorum sublimis, and also those of the flexor digitorum profundus.

There are crucial ligaments, which bind down the tendons of the flexor muscles.

There are also accessory ligaments of the flexor tendons, which arise from the first and second phalanges of the fingers; and are lodged within the vaginal ligaments, which terminate in the tendons of the flexor muscles, and assist in retaining the tendons of the flexor muscles in their places.

The tendons of the extensor muscles are united by transverse ligaments, near to the heads of the metacarpal bones, and are thus retained in their places.

SECTION V.

OF THE LIGAMENTS OF THE PELVIS AND INFERIOR EXTREMITIES.

OF THE LIGAMENTS OF THE PELVIS.

What has been already stated respecting the ligaments of the superior extremities, applies also to those of the inferior extremities; and, in addition, it may be remarked, that the organic derangements of the ligaments of the inferior extremities are of a more alarming nature than those of the superior. They more seldom yield, even to the most judicious treatment; and, besides, the general health is more apt to suffer materially, as they necessarily lead to confinement.

The bones of the pelvis, which support the weight of the trunk of the body, and also serve as the basis on which the inferior extremities move, are firmly fixed to each other, by several strong ligaments.

The form of the bones of the pelvis contributes much to the firmness of it.

The os sacrum, on account of the oblique direction of its articulating surfaces, is like a wedge placed between the ossa innominata; the extremities of each of which bones are arched forwards, and united at the symphysis pubis; hence the greater the depressing power, the more closely the bones of the pelvis are pushed together.

Front View.

The os sacrum is united to the fifth lumbar vertebra, and to the ossa innominata, by very strong ligaments, from which there is a ligament which sweeps along the upper aperture of the pelvis.

There are small apertures in the above ligament for the passage of the lumbar nerves.

The sacrum and ossa innominata are also joined at the sacro-iliac symphysis by ligamento-cartilaginous substances,

which can only be seen when the bodies have been forcibly separated.

The crural arch is seen extending from the anterior and superior spinous process of the ilium, and with its fibres inserted into the opposite os pubis. A few ligamentous fibres extend downwards from the superior and anterior spinous process of the os ilium, to the inferior and anterior spinous process of the os ilium *.

A strong capsular ligament unites the surfaces of the ossa pubis, which are in contact at the interior of the symphysis pubis, from which there is, on each side, a round and strong ligament, which descends to the tuberosities of the ischia, and between the ossa pubis there is a ligamento-cartilaginous substance, composed of fibres passing in a transverse direction, or sometimes two cartilaginous substances, broader in the female than in the male.

The obturator foramen is filled up by a ligament, in which there is a large aperture for the obturator artery and nerve, and three other small apertures, from which small branches of the obturator artery, vein and nerve pass outwards, and get into the acetabulum, to supply the synovial apparatus within the hip-joint.

Back View of the Pelvis.

There are two ligaments disposed transversely, which unite the os sacrum to the ossa innominata, besides a general capsular ligament, and there is within the joint a ligamento-cartilaginous substance.

A long and strong ligament called *ilio-sacral*, originates from the posterior spinous process of the spine of the os ilium, and descending obliquely is fixed into the lower part of the os sacrum.

There is also a shorter ligament which is fixed higher into the os sacrum.

The posterior part of the os sacrum is covered by a liga-

* For a more particular description of this ligament, see account of the muscles of the fore-part of the abdomen.

mentous crust, the fibres of which follow different directions, and which extends along the under part of the bone, to the lower extremity of the ossa coccygis.

By the larger external ligament, the large notch in the ilium is converted into a hole for the passage of the pyriform muscle, the great sciatic nerve, and the gluteal arteries.

The most important ligaments of the pelvis are two strong ligaments, of unequal size, situated at the under aperture of the pelvis, and which have been called, on account of their situation, *sacro-sciatic*, as they are placed between the os sacrum and os ischium. The longer arises from the back of the crest of the os ilium, from the transverse process of the os sacrum, from the back part of the same bone, and also from the ossa coccygis, and is fixed to the ligamentous crust which covers the tuberosity of the os ischium.

That portion of this ligament, which is attached to the back part of the spine of the os ilium, being thinner than the other portions of the same ligament, has been called its membranous part, or appendix; and the inferior portion of the same ligament, which descends in the form of a sickle, along the inner part of the tuber ischii, with its concavity looking inwards, and with its narrow end directed upwards, towards the descending ramus of the pubis, has been called, on account of its shape, *the falciform process* of the sacro-sciatic ligament.

The shorter sacro-sciatic ligament takes its origin from the side of the os sacrum and ossa coccygis, and is fixed to the spine of the ischium.

The muscle called *obturator internus* passes between the sacro-sciatic ligaments.

The large holes in the back part of the os sacrum, are in a great measure filled by ligaments, which pass from one tubercle to another, and the back part of the ossa coccygis is covered by ligaments which pass along these in a longitudinal direction, and which are fixed into the extremity of the last bone of the os coccygis *.

* Loder's Plates, xxi. and xxii. which represent the Ligaments of the Pelvis, are very faithful copies of Nature.

Of the Ligaments of the Hip-Joint.

The capsular ligament of the hip-joint is connected with the margin of the acetabulum, and descending, is fixed into the prominent line of the thigh-bone, which extends between the trochanter major and minor, so as to include not only the head, but also the neck of the thigh-bone, and descends lower upon the anterior than on the posterior part of the neck of the bone. This ligament is reflected inwards, towards the head of the bone.

The capsular ligament is not of an uniform thickness; it is thicker at its upper and back part than elsewhere, and is strengthened, on its fore-part, by a band of ligamentous fibres, which arise between the two origins of the rectus extensor cruris; and behind there is also an accessory band of ligamentous fibres.

The capsular ligament is strengthened in front by the psoas and iliacus internus and rectus cruris muscles; internally, by the obturator externus and pectineus muscles; behind, by the gemini, the pyramidales, and the tendon of the obturator internus; above, by the gluteus minimus muscle.

This acetabulum is lined by cartilage, as also the head of the thigh-bone. These articular cartilages are of unequal thickness, the former being thinnest towards the centre of the joint, whereas, the corresponding portion of the latter is thicker than in any other part, in order to render the joint deeper, and at the same time stronger.

There is a ligament within this joint somewhat of a triangular shape, which consists of two parts; one of these is fixed to the under and inner part of the acetabulum, and is connected to the substance called formerly the *gland* of the joint, from which it becomes gradually narrower; and the other is fixed to the notch in the acetabulum. These parts are united and inserted into the pit, upon the inner surface of the ball of the thigh-bone.

This ligament gives great additional security to the joint; it prevents the displacement of the head of the thigh-bone. In a case in which there was thickening and erosion of the

articular cartilages, and also slight erosion of the brim of the acetabulum, this internal ligament, together with the synovial apparatus, was completely destroyed.

A double *cartilago-ligamentous membrane* is stretched across the breach in the inner and fore part of the acetabulum; in the posterior part of which there is an aperture for lodging a part of the synovial apparatus.

The bony margin of the acetabulum is encircled by a ligament, which adds considerably to its depth, and is called the *cotyloid ligament.*

Owing to the greater shortness of the capsular ligament of the hip-joint, and the greater depth and immobility of the acetabulum, the movements of the thigh-bone are much more circumscribed than those of the os humeri.

The ligamentous fibres which pass from the anterior and superior, and anterior and inferior spinous processes of the os ilium, prevent the thigh-bone from being carried backward, beyond a perpendicular line drawn from the pelvis downwards.

Of the Synovial Apparatus of the Hip-Joint.

The acetabulum is lined by the synovial membrane, which also covers the synovial apparatus of this joint, lodged within the acetabulum: it is then reflected over the *internal ligament* of the joint, over the cartilage which covers the head of the thigh-bone, and also over the neck of the same bone.

The synovial membrane is very vascular, and is supplied with blood from the smaller branches of the obturator artery *.

There are a number of fringes connected with the synovial apparatus, from which the synovia may be squeezed out.

The edges of the synovial apparatus are retained in their situation, by small ligamentous fibres.

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* Vid. the synovial apparatus of this joint, represented of its natural size, in fig. 3. of Plate viii. of my Father's book on the Bursæ Mucosæ, and magnified in fig. 4. of the same Plate.

Of the Cartilages and Ligaments of the Knee-Joint.

The knee-joint is formed by the contact of the condyles of the thigh-bone with the head of the tibia, and back-part of the rotula.

Each of these bones has its proper articular cartilage, and they are kept together by strong ligaments, which prevent the joint from being bent or extended to too great a degree.

A strong capsular ligament is connected to the circumference of the lower end of the thigh-bone, and is fixed to the head of the tibia, and the margin of the articulating surface of the patella, so that the patella forms a part of the capsule of the joint.

This ligament is strengthened by lateral ligaments, by a tendinous aponeurosis from the tendons of the extensor muscles, and by the general tendinous aponeurosis of the limb.

There are two lateral ligaments, which are external to the general capsular ligament; the longer and stronger extends from the tubercle, about the external condyle of the thigh-bone, to the head of the fibula, and is covered by the tendon of the biceps; and behind this there is a shorter and thinner ligament similarly situated.

The internal ligament is of considerable breadth; it passes between the internal condyle of the thigh-bone. The tibia becoming broader as it descends, is inserted into the edge of the internal semilunar cartilage, and into the upper and inner part of the head of the tibia. This ligament, at its insertion, is covered by the tendons of the gracilis, semitendinosus, and sartorius muscles.

There are also irregular bands of ligamentous fibres, which extend between the condyles of the thigh-bone, and the upper and inner part of the head of the tibia. A few of these fibres, which descend obliquely from the external condyle of the thigh-bone to the tibia, are stronger than the others, and have been said, by Winslow, to form the ligamentum posticum.

There is a ligament connecting the patella to the tuberosity at the upper and fore-part of the tibia; and, in some subjects,

there is a strong transverse ligament, which fixes the head of the tibia to that of the fibula.

Of the Internal Ligaments of the Knee-Joint.

The capsular ligament is reflected, and forms the lateral ligaments, called *alaria externa*, and *interna*, by which the synovial apparatus is fixed to the sides of the patella; and this apparatus is also fixed by a ligamentum mucosum, which is continued from the union of the ligamenta alaria, to the cavity of the thigh-bone between its condyles, and immediately in front of the anterior crucial ligament.

There are two internal ligaments which cross each other, hence named *crucial*. The one is fixed to the semilunar shaped notch, between the condyles of the thigh-bones, and to the pit at the fore-part of the protuberance in the middle of the head of the tibia; and the other, which is fixed in a similar manner to the thigh-bone, passes behind the former, and is fixed into a pit behind the above named protuberance.

The crucial ligaments are relaxed when the knee is bent, but when the joint is extended they are stretched; and they admit of the thigh-bone and tibia to be brought only into a straight line with each other.

The head of the tibia is divided by a protuberance of bone, into two parts, each of which is somewhat excavated: each cavity is rendered deeper by a cartilage, somewhat of the form of a crescent, which surrounds that cavity; which cartilage, towards the middle of the bone, is as thin as the blade of a knife; but in its outer circumference, three or four lines in the thickness; and the thicker parts of these cartilages being connected to the capsular ligaments, scarcely change their places.

The upper surface of these cartilages is concave, the lower nearly flat. These cartilages are connected to each other at their inner cornua, by a small transverse ligament.

Ligaments of the Patella.

The patella is fixed in its place, by the tendon of the extensor muscles of the leg, which is fixed into it, and by a strong ligament, which passes between the under part of the knee-pan, and the anterior tuberosity of the tibia.

Of the Synovial Apparatus of the Knee-Joint.

The synovial apparatus of this joint is of great extent *. When traced from above, it is reflected from the condyles of the thigh-bone, to the circumference of the knee-pan. In this part it is loose, and covered above by loose fat. After lining the posterior surface of the patella, it passes on the upper edge of the tibia, and covers the articular cartilages.

Ligaments between the Tibia and Fibula.

The upper extremity of the fibula, is connected by a capsular ligament to the outer surface of the tibia, by the external lateral ligament of the knee-joint, and by the tendon of the biceps flexor cruris, which is fixed to the fibula.

There is a strong *interosseous ligament*, composed of oblique fibres, which extends between the ridge at the back part of the tibia, and the corresponding ridge at the inner side of the fibula.

There being a large aperture in the upper part of the interosseous ligament, the muscles of the fore and back part of the leg are in contact; several small bloodvessels pass to the fore-part of the leg, through the interosseous ligament.

There are several ligaments which unite the inferior extremity of the fibula and tibia.

Ligaments connecting the Bones of the Leg and Tarsus.

The capsular ligament, which is fixed to the margin of the articular cavity of the tibia, fibula, and astragalus, is very thin, especially before and behind.

It is strengthened, as CALDANI has represented in fig. 6. of his 59th Plate, by an upper and under ligament, passing from the lower and back part of the tibia to the fibula; by a perpendicular ligament which passes from the malleolus externus, to the os calcis; by an anterior and a posterior ligament, the former of which arises from the anterior part of the

* Vide MONRO on the Bursæ Mucosæ, Plate viii, fig. 5, 6, 9, and 10.; in which this apparatus is seen, of its natural size, and also much magnified.

malleolus externus, and is fixed to the astragalus, and the latter arises from the posterior part of the malleolus externus, and is fixed to the outer and posterior part of the astragalus.

There is also a ligament which arises from the malleolus internus, the fibres of which follow a radiated course, and are fixed to the astragalus, os calcis, and os naviculare.

Ligaments of the Tarsus.

The astragalus is articulated by two cartilaginous planes to the os calcis.

There are several short irregular ligaments which assist in uniting the above bones.

There are lateral and inferior ligaments, fixing together the os calcis and os cuboides.

The convex articular surface of the astragalus is received by a concave surface of the os naviculare, and three short ligaments for retaining these bones in contact.

The movements of the bones of the tarsus are very limited, excepting those between the os calcis and os naviculare. The foot moves outwardly and inwardly upon the os naviculare.

The os naviculare and cuboid bones may be moved upwards and downwards to a slight degree, and the cuneiform bones move slightly on the os naviculare and on each other, by which the foot is more accurately adapted to irregularities on the ground in walking.

Ligaments of the Bones of the Feet.

There are transverse ligaments which unite the os naviculare and cuboides.

There are superior, lateral, and plantar ligaments, which unite the os naviculare and os cuneiforme, and many ligaments uniting the os cuneiforme and os cuboides.

The cuneiform bones are united by many dorsal and plantar ligaments.

Ligaments which connect the bones of the Tarsus and Metatarsus, and the Metatarsal Bones to each other.

The bones of the metatarsus and tarsus, are united by cap-

sular ligaments, and also by other short ligaments called, from their situation, *dorsal*, *plantar*, *lateral*, and, from the direction of their fibres, *straight*, *oblique*, and *transverse*.

Ligaments of the Phalanges of the Toes.

The capsular and lateral ligaments of the phalanges of the toes are similar to those of the fingers, and the tendons of the extensor and flexor muscles are inclosed within similar sheaths, or oblong bursæ.

Before concluding respecting the ligaments, it may be observed, that the synovial membranes, like other serous membranes, are very frequently inflamed, which occasions an increased secretion of synovia, the effusion of coagulable lymph, or the thickening of the synovial membrane.

According to Mr Brodie, the inflammation of the synovial membrane has sometimes given rise to the destruction of the articular cartilages.

A chronic inflammation of the synovial membrane, is also the consequence of the acute inflammation, of taking mercury, or of rheumatism, or it is occasioned by cold, and hence is most frequent in the knee and ankle joints.

The chronic inflammation of the synovial membrane sometimes leaves one joint, and attacks another.

On account of the swelling of the joint occasioned by the fluid within the capsular ligament, the alteration in the form of the joint, and the great pain on motion, this case has sometimes been mistaken for fracture of the head of the bones, or for a dislocation, the form of the joint being much changed owing to the distention of the synovial membrane by the included fluid; hence the form of the diseased joint is modified by the contiguous tendons and ligaments, which resist in certain directions, but yield in others.

PART III.

OF THE MUSCLES, TENDONS, TENDINOUS APONEUROSES, AND BURSÆ MUCOSÆ.

CHAP. I.

ON THE MUSCLES AND TENDONS.

SECTION I.

GENERAL OBSERVATIONS ON THE MUSCLES AND TENDONS.

THE flesh or muscles constitute a large portion of the bulk of the bodies of animals.

The muscles are subservient to various and very important offices in the animal economy. They are the instruments of locomotion, speech, chewing, sucking, swallowing, singing, &c., and by the same means the blood, the contents of the alimentary canal, and of the different excretory ducts of the glands, are propelled.

The muscles are composed of soft, moist, flexible, semipellucid fibres, possessing a small share of elasticity.

The fibres of the muscles of the class Mammalia have a red colour, but in the inferior animals they are white; and between the fibres a quantity of cellular substance, albumen, jelly and fat, is interposed.

The size of the muscular fibre is not proportioned to the bulk of the animal; it varies also in the different muscles of the same animal. There is a considerable difference as to the density of the muscular fibres. The density varies very much in the different sexes, and in different muscles of the same animal, being greatest in those muscles which are most exerted. In very early life, and in old age, the muscles are much softer than in the meridian of life. The density bears

a ratio to the strength of the muscle; for the muscles are invigorated, become denser and larger by use, and acquire greater force and energy. This truth is also strongly exemplified, by comparing the same muscles in wild and domestic birds. It is proper also to add, that the muscles of some men, are originally much firmer and stronger, than those of most men, hence the former are much stronger than the latter, even though not invigorated by use. The former are hard, red coloured, fibrous, tough, and strong smelling; the latter are soft, white, and delicate. The form of the different muscles is very various; being modified and adapted to their particular office, as it is a law in the animal economy, that a muscle always contracts towards its centre. The same muscle in different persons, is not only larger, but of different lengths in men of the same stature: which is a part of original formation; thus the quantity of contraction is diminished, and the velocity consequently increased in a very considerable degree.

The larger fibres of the muscles may be subdivided into smaller fibres. Leewenhoek, whose microscopical observations were so celebrated, supposed he had discovered the ultimate division of a muscle, and calculates, that in the fibres of some muscles there are 3200 filaments. The ultimate filaments have been said to be solid *, hollow †, or vesicular ‡. To me the smaller fibres seem to be solid, and perfectly similar to the larger.

The smaller fibres of a muscle are united by cellular substance and fat.

Of the coverings of Muscle.

The muscles are covered by cellular membrane and fat, which, together with the serous fluid which is proper to the cellular membrane, renders our movements more ready and easy.

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* Gottskhed. Boerhaave.

† Borelli, Hooke, Stewart, Bernouilli, Baglivi, Astruc, Senac, Quesnay.

‡ Muys, Cowper, Kaaw Boerhaave.

Bloodvessels of Muscles.

The bellies of muscles of the class Mammalia derive their red colour from the number of bloodvessels which are dispersed through their whole substance; for their fibres, when steeped in water, become grey or white, and very like to the fibrina of the blood.

The bloodvessels pass between the larger fasciculi of the muscle. As the quantity of blood varies in the different muscles, so does the colour, which seems to depend on the frequency of employment of the muscles; for even in the same animal, the colour of the muscle differs in the wild and domestic: Thus, the pectoral muscles of the wild duck are of a red colour, and those of the legs are pale; and the reverse holds true in the domestic duck.

The bloodvessels and absorbent vessels bear, generally speaking, a ratio to the size of the muscle, and increase in size when the muscle increases in size; of which, the uterus affords a striking illustration; for, in its gravid state, the bloodvessels and absorbent vessels are much larger than in the virgin state. When the action of the muscles is slow, the blood passes through a number of small branches, lest it should too quickly arrive at its destination.

When muscles have not been exercised, they lose considerably of their bulk, and less blood is sent to them; the same quantity of blood is not, in these circumstances, necessary. In short, the blood seems to be essentially necessary; for, during vigorous exertion of the muscles, the bloodvessels of the muscles are thrown into violent action, and swell out; and they again subside, when the muscles have ceased to act.

Lymphatic vessels of Muscles.

Besides bloodvessels, the muscles have large and numerous lymphatic vessels.

It is probable that we have as yet discovered only a few of the lymphatic vessels which are proper to the human muscles; for the valves of these vessels perform their office so accurate-

ly, as to prevent even a very fine liquor from passing from the larger into the smaller ramifications.

But in the skate *, there are no valves in the small lymphatic vessels; and hence, by a successful injection, the smaller branches of the lymphatic vessels may be filled; and these vessels, when filled by a liquor coloured with vermilion, are so abundant as to give a red tinge to the part.

Nerves of Muscles.

The bloodvessels of the muscles are accompanied by nerves, which divide into so many and so small branches, as to elude the knife of the anatomist. For it is probable, that each muscular fibre has its correspondent nervous filament.

The nerves of the muscles are not proportioned to their size; those of the muscles of voluntary motion being large and numerous, whereas those of the involuntary muscles are very small. The nerves of the heart are small, which led Behrends† to deny their existence, though he admits that nerves are distributed upon the coats of the coronary arteries, which, for the anatomist, was a fortunate circumstance, as it gave rise to the publication of Scarpa's very beautiful and correct representations of the nerves of the neck and thorax.

Many muscles receive nerves from various sources, and antagonist muscles, in many instances, from the same sources ‡.

Wounds, laceration, inflammation, and other diseases, prove the great sensibility of these organs. There are many substances which have the effect of hardening the muscular fibre, as alkohol, diluted acids, alum, common salt, and saltpetre; the two last render the muscular flesh redder.

The muscles have been called by some authors the *moving extremities of the nerves*, upon which opinion my Father has published the following comment:

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* Vide Monro on Fishes.

† Vide Ludwig. Scriptor. Neurolog. Minor, Vol. iii.

‡ Vide Monro's Nervous System.

" 1. Muscular fibres, in consequence of their office, have considerable strength and toughness; whereas the nerves, even when covered with their pia mater, (which those very authors suppose them to lay aside at their terminations), are pulpy and soft.

" 2. The matter which we know for certain to be medullary or nervous, does not appear to be endowed with the power of contracting when irritated.

" 3. As the nerves consist of threads laid parallel to each other, and which do not, like the bloodvessels, divide into branches, the bulk of which greatly exceeds that of the trunks which produce them, how are we to conceive that a small nerve can form a much larger mass of flesh?

" 4. If the muscles were formed by the extremities of the nerves, they should shrink very remarkably on cutting the nerves, instead of which, I have observed no sensible alteration in the appearance of the muscles of the thigh and leg of a frog, upwards of a year after I had cut across its spinal marrow or sciatic nerves.

" Muscles, or muscular fibres, seem, therefore, to be *organs sui generis*, not produced by the nerves, but merely influenced by the energy they convey *."

Tendons of Muscles.

The tendons, like the muscles, are in structure fibrous, but their fibres are white, small, and closely united to each other, and have a shining silvery appearance. The fibres of tendons are very tough, and possess very little elasticity. In many instances, the fibres of the tendons are evidently collected into fasciculi of considerable size. There are but few bloodvessels proper to tendons, and no nerves or lymphatic vessels.

In many of the tendons, the fibres follow nearly the same direction as the fibres of the muscles: hence tendons have been stated by some authors *to be muscles indurated by pressure*. But the direction of the fibres of the tendons is, in

* Vide Nervous System, p. 90. and 91.

many instances, different from that of the muscles; for there are many muscles with rectilinear tendons, and also tendons with rectilinear fibres, common to two muscles, the fibres of which have different degrees of obliquity.

There are many muscles in which the tendon occupies the middle of the muscle, and the fibres are placed obliquely with respect to the tendon, like the plume of a pen. Such muscles have been named *Penniform Muscles.* There are other muscles, in which the tendons are situated at the sides of the muscles; these have been called *Semipenniform;* and in some muscles several penniform muscles are combined, which have been named *Compound Penniform Muscles.*

The tendons are subservient to various purposes.

1*st*, They serve to unite the cartilages and bones to each other; as where they supply the place of the external intercostal muscles, or where they unite the bones of the fore-arm or of the leg to each other.

2*d*, Tendons add to the strength of the capsular ligaments.

3*d*, The tendinous aponeuroses, as the fasciæ of the superior and inferior extremities, are conducive to the symmetry of the body, and particularly to that of the limbs, and also to the defence of the muscles.

4*th*, The tendinous aponeuroses not only defend the muscles, but increase greatly the surfaces from which the muscular fibres take their origin; of which there are many examples in the back, and in the extremities of the body, in the fore-arms, thighs and legs; and, in some places, there are two or more muscles, the fibres of which are differently directed, and subservient to different purposes, taking their origin from the opposite sides of the same tendinous membrane.

5*th*, There are rounded tendinous cords, which serve to connect muscles to distant bones, where there is not room for the bellies of all the muscles which are necessary for the motion of the joints; and without such a medium of attachment, the joints must have been unwieldy and of great bulk, and there might have been the risk of the muscles interfering with each other, or of their proving injurious to the neighbouring blood-vessels and nerves.

6th, There are annular tendinous ligaments, as at the wrists and ankles, which serve to fix down the round tendons, and to strengthen the bursæ within which the tendons play.

Lastly, Some tendons fix down other tendons: thus the tendons of the long flexor muscles of the fingers and toes pass through each other.

Origin and Insertion of Muscles.

A muscle is said by anatomists to consist of a belly and two extremities. The *belly* is composed of a great number of fleshy fibres; and to the extremities of many of the muscles a white glistening cord or membrane is connected, called *tendon*, or *tendinous aponeurosis*, by which many of the muscles are fixed to the bones. The extremity, which is connected to the most fixed part, is named the *head*, or *origin* of the muscle; and the other extremity, fixed to the more moveable part, the *insertion* of the muscle.

The greater number of the muscles by which we transport ourselves from place to place, are attached to, and supported by, the bones, and are laid over them in layers. In most cases, the muscle is stretched from one bone to another; or a muscle is said to arise from one bone, and to be inserted into another.

Chemical Analysis of Muscles.

This branch of animal chemistry is still involved in obscurity, owing to the difficulty of separating the muscular fibres from the blood, fat, and cellular substance, with which they are very intimately involved.

To Messrs Thouvenel, Fourcroy, Vauquelin and Hatchett, we are chiefly indebted for our knowledge of the chemical composition of the muscular fibre.

A muscle, when washed, is converted into a white fibrous substance, which retains the form of the muscle: this consists chiefly of fibrine; 2d, of albumen; 3d, of jelly; 4th, of extractive; 5th of phosphate of soda: and Mr Hatchett discovered in beef, phosphate of ammonia, and the phosphate

and carbonate of lime. Muscular flesh, by boiling, yields jelly, albumen, a peculiar extractive matter described by THOUVENEL, phosphate of soda and ammonia, and a fibrous substance like fibrine.

Nomenclature of Muscles.

The muscles of the human body have been named by DOUGLAS, ALBINUS, INNES, and other authors, from their size* breadth† and length‡, form§, their being straight‖, or oblique¶, from their situation**, or supposed office††; but there are many objections to such names.

In the following pages, it is proposed to adopt such names as are descriptive of the situation of the muscles; and where a muscle has several origins, it is necessary to employ such a name as describes the chief origins and insertions only, in order to avoid words of many syllables.

Classification of Muscles.

There have been two methods of arranging the muscles. According to the one, muscles are arranged according to their uses; according to the other, from their situation. The latter is the method of ALBINUS, which has been adopted by most of the modern anatomists.

Such a method is, perhaps, the most natural, and most favourable for teaching dissection, but it communicates a very imperfect idea of their uses, and of the mode in which they antagonize each other.

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* Greater and smaller pectoral muscle.

† Latissimus Dorsi, Vasti interni et externi, &c.

‡ Longissimus dorsi, Longus colli, &c.

§ Deltoid, Rhomboid, Scaleni, Trapezii, &c.

‖ Rectus abdominis, Rectus cruris, &c.

¶ Obliqui abdominis, Obliqui capitis, &c.

** Glutei, Pectoral, Orbiculares oculi, &c.

†† Biceps flexor cubiti; Biceps flexor cruris; Attollens aurem; Corrugator supercilii; Levator, Depressor, Adductor, Abductor oculi; Sartorius, &c.

I propose to adopt both plans, viz. to name the muscles as they present upon dissection, and then to arrange them into classes, according to their several uses.

Contraction of Muscles.

There are many striking instances of a powerful muscular action in the smaller animals, particularly in insects, in which the apparatus subservient to that purpose is not obvious to our imperfect senses.

The muscles are extremely irritable, and contract when irritated, and this irritability is various in the different muscles. A power of contraction is the most characteristic property of a muscle. Sir EVERARD HOME * says, the principle of contraction is independent of the organization, since it (a muscle) can undergo a complete change within itself; so that its fibres shall be shortened to one-half of their original length, and still have the same contractile power as in the original state. This is proved by a case of a fractured knee-pan, where the pieces were not closely united. He desired the patient to sit on a table; and the extensor muscles of the leg, which at first were not under the dominion of the will, became so in time; so that a new action took place. The same was proved by a case where a humerus was broken, and the broken ends crossed each other, and adhered in that situation; the biceps shortened itself, and acquired power of contraction.

The whole of a muscle, or only a part of it, contracts itself upon the application of a stimulus. It acts only by contractions; and, when the exertion ceases, it relaxes itself considerably. When a muscle contracts, the belly of the muscle becomes hard, its parts are drawn more closely together; it becomes rough on its surface and swells; its smaller fibres assume a waved or zig-zag appearance, and its extremities approach each other: the muscle, in consequence of this action, draws the least moveable towards the more fixed part, to which

* Lect. on Comp. Anat. Vol. I. p. 40.

its extremity is connected. When a hollow muscle contracts, it diminishes its cavity in all directions. The muscles which have the greatest share of mobility are least capable of permanent contraction, as those of the voice or tongue; thus we experience fatigue, by pressing the tongue for some time against the palate.

The muscular fibre varies its operation, according to the purpose to be served; for instance, when a muscular fibre is punctured, it vibrates, which is the fittest means of throwing off the offending cause: the alimentary canal, acted on gently by the food, performs a very complex peristaltic motion and anti-peristaltic motion; the abdominal muscles act slowly and steadily in expelling the contents of the rectum, but suddenly and convulsively in vomiting; the bladder of urine, from which there is a small outlet only, performs a slow and uniform contraction in discharging its contents; whilst the heart contracts with a jerk, and is drawn towards the more fixed point. A permanent and unusual degree of contraction in a muscle is called *spasm;* and, when the contractions are quickly repeated, it is called *convulsion.*

Muscles, Voluntary, Involuntary, Mixed.

There are some muscles which are under the direct influence of the will; these have been called *voluntary muscles.* Such are the muscles of locomotion. But there are other muscles, over which the will has no dominion: these, therefore, have been called *involuntary muscles.* We neither possess the power of throwing those muscles into action, nor can we prevent them from acting.

The heart, arteries, and intestines, afford examples of this description; and it is remarkable, that such muscles are not fatigued by continued action. But this is an arbitrary division: for all the muscles are occasionally strictly involuntary, as the mind is not conscious of their being thrown into action; and the same observation applies to disease, as in chorea, trismus, opisthotonos (when the body is bent backwards), and emprosthotonos (when it is bent forwards).

It may not be improper to add, that some of the muscles which are *not* in man obedient to the will, *are so* in some animals; thus, in ruminating animals, the stomach is a voluntary muscle; and, farther, even in the human body, those muscles which are involuntary are, in consequence of violent passions of the mind, sometimes excited, as palpitation of the heart, by anger or fear.

The nerves which lead to the *voluntary muscles* are much larger than those proper to the *involuntary muscles;* yet the irritability of the latter class is more durable, and more readily excited than that of the former class. The irritability, therefore, of a muscle, is by no means proportioned to the size of the nerves. The degree of contraction of the involuntary muscles is less than that of muscles under the dominion of the will.

There is a third and intermediate class of muscles, which has been named *mixed,* as we can at pleasure increase or modify their action, but cannot stop it altogether, or for a great length of time. The diaphragm, and muscles of respiration, are included in this class. Of the action of this third class of muscles we are not sensible, unless the attention of the mind be directed to it. When such muscles act in an unnatural manner, or when their action is impeded, then we suffer very great distress. But, by habit, we become capable of suspending the action of these muscles for a much longer time; thus divers are said to be capable of suspending their breathing for some minutes, without oppression.

Under this class the sphincter muscles may perhaps be included: they are not constantly, but only occasionally, under the dominion of the will.

The degree of contraction of muscles is very various: it has generally been said that muscles *contract one-third only of their length;* but many muscles, as those of the bladder of urine, and the sphincter of the mouth, are capable *of contracting two-thirds,* if not more.

Does a muscle (as supposed by older authors) increase in its density when it contracts?

Sir G. Blane's experiment on the tail of the eel seems to determine this question in the negative *.

There are great numbers of stimuli which produce the contraction of muscles, of which the nervous energy is certainly the chief.

The integrity of the *nerve* and artery leading to a muscle *is essential to its action;* for a ligature thrown around that nerve, or the dividing it, renders the muscle paralytic, or incapable of action; and further, the cause of this palsy is generally resident in the brain and spinal marrow, from whence the nerve originates, and not in the part affected.

Relaxation of Muscles.

Until the causes of contraction are fully understood, those which induce relaxation of the muscles must be obscure. Contraction and relaxation take place regularly, and constantly and alternately in the heart, as the circulation could not otherwise have been properly carried on; and even after the heart is separated from the body, when its most common and principal stimulus the blood, is wanting, these alternate actions continue for some time.

During respiration, contraction and relaxation alternately take place, but less regularly, for a great number of useful purposes. If a muscle be kept for a length of time in a state

* "I took a glass flask, into which one-half of a living eel was introduced. The mouth was immediately afterwards fused by a blowpipe, and drawn into a tube like the stem of a thermometer. The flask and tube were then filled with water, in order to see whether the motion of the animal would make the fluid rise or fall. *It had neither the one effect nor the other*, though there were at times strong convulsions; and if the muscles had at any time occupied *either more space or less than another*, a sensible fluctuation would have been produced, especially when the column of fluid was rendered very fine, by the introduction of a steel-wire to irritate the parts. That part of the eel from the anus to the tail was made use of for this experiment, as the other division, containing the organs of respiration and the air-bladder, might have occasioned a fallacy, from the expansion or condensation of an elastic fluid, by accidental changes of temperature or compression. This was repeated three times, with the same result. In one of the trials, the above-mentioned portion of two eels was introduced; and though they were at times both in convulsions at once, not the least motion of the fluid in the tube had been perceived."—Blane's *Lecture on Muscular Motion*, p. 13.

of contraction, fatigue is occasioned; the muscle remains at first firm, but in time a little quivering is felt; and, when a muscle is exhausted, alternate contractions and relaxations may be observed, excepting in cases of spasmodic contraction, such as is induced by tetanus. In one form of spasm, the arm may be put into a posture which it will preserve for some time.

The muscles which are commonly called voluntary, as those of the limbs, may remain in the state of relaxation for a number of hours; and a sphincter muscle, such as a sphincter ani, may continue for the same number of hours in a state of contraction; and hence the voluntary muscles or the sphincter muscles cannot be said to be in an alternate state of contraction and relaxation, as we possess the power of throwing our muscles into that state which is most conducive to our safety and convenience.

The heart and the intercostal muscles are perhaps more completely relaxed than the ordinary muscles, in order that the blood and the air may enter the heart and lungs more freely.

The relaxation of the voluntary muscles is less complete, or in a sort of middle state, such as makes them ready for a greater degree of either state, without requiring such an exertion as exhausts the nervous energy.

A moderate degree of contraction is constantly taking place in all our muscles, as is evident in those of the face in the case of hemiplegia, the diseased side being evidently much more relaxed than the sound.

There are many striking peculiarities as to the contractions and relaxations of muscles. There are some muscles in which we seldom or never experience fatigue, as the heart and muscles of respiration. There are others which, if alternately contracted and relaxed, are not fatigued, as those of the fingers and toes; but fatigue is soon felt if fingers or toes are kept contracted, even for a short time; and thus, also, the muscles of the larynx may be alternately exerted without fatigue for a considerable time, but if one sound be kept up, even for a short time, we feel fatigued.

The muscles of the back of the neck and back support the head and trunk of the body erect for a whole day, and are equipoised by the muscles of the belly, but if the head or

body be kept in an unusual position for a short time, we experience much fatigue.

The above observations do not apply to the muscles of the extremities, for their action may be diversified to a much greater degree without fatigue, but by them we are less capable of continuing the same action, as of extending the arm for an equal length of time, without experiencing much fatigue. But when the contraction of muscles is increased or repeated more frequently than is usual, then we experience fatigue in a very short time. Thus, in the ordinary breathing, the diaphragm and intercostal muscles act constantly, and without fatigue, but laughing, which is an involuntary action, soon becomes excessively distressing.

Observations on the Collocation of Muscles.

By means of the muscles on the fore and back parts of the body, it is kept in equilibrium, and many of the muscles of the trunk of the body combine with those of the lower extremities in the function of locomotion; the muscles of the breast and shoulder move the upper extremity, those of the forearm move the fingers, and the muscles of the neck and upper part of the back part of the body serve for moving the head and supporting it.

Galen, in his treatise De Usu Partium, has described the several qualifications of each particular muscle, its position, figure, just magnitude, its fulcrum, its point of action, and its collocation with respect to its two ends.

The movements of the body are regulated by the form of the bones, the disposition of the articular surfaces, the manner in which the muscles are fixed to the bones, and the direction of the muscular fibres.

1st, *There is an exact relation between the joint and the muscles which move it.*

Thus, at the elbow and knee joints there are muscles capable of performing flexion and extension only; but at the shoulder and hip joints, muscles are superadded, for performing the rotatory movements of which these joints admit.

2d, *Muscles act only by contractile power; the contraction*

is succeeded by relaxation, by which the muscle returns to its former state.

Such being the nature of the muscles, it follows, that motion can be produced only by the agency of antagonist muscles, of flexor and extensor muscles; and where balancing of the body is required, the flexions and extensions are accommodated to the centre of gravity, or *vice versâ.*

Such a disposition of the muscles is also conducive to the aspect and symmetry of the body: thus the mouth, for instance, is kept in the middle of the face, by the agency of the muscles of its opposite sides balancing each other, as is very evident when the equipoise is destroyed by a palsy of the muscles of one side of the face, for then the mouth is drawn to the opposite side.

It is evident that the centre of gravity varies in the different attitudes of the body; and hence a number of muscles must be thrown into action to maintain the equilibrium, or there are muscles which modify or limit the action of the flexor and extensor muscles.

3d, *The muscles are so disposed as not to interfere with one another.*

4th, *The action of many muscles accords with their position and form.*

From the position and form of the muscles an estimate may be formed of their action; the contraction of muscles being towards their centre, the figure of the muscle is adjusted, and its form modified, so as to produce the necessary motion: thus the long muscles stretched between certain points must draw these towards each other when they contract; a hollow muscle, like the bladder of urine, discharges its contents; and a sphincter muscle, from the circular disposition of its fibres, and its position, is well adapted for a contracted state, sufficient for retention, but which may be overcome when it is necessary.

5th, *Many of our movements are accomplished by the combined action of several muscles.*

The movements of many parts of our bodies are the result of the combined action of several muscles; and frequent-

ly, diagonal motion is produced, the tendons of the muscles pulling in the direction of the sides of a parallelogram; for example, the head is drawn downwards in the diagonal by the combined action of the sterno-cleido-mastoidei muscles, and sidewise towards the shoulder by the combined action of the sterno-cleido-mastoid and the splenii muscles.

Strength of Muscles.

It has been already noticed, that the muscles become by exertion larger and also stronger; it is probable that they also become more dense, for in consequence of exercise, the process of absorption during exertion takes place more rapidly, and the fat between the fibres of the muscles is removed, while, at the same time, the circulation in the minute vessels becomes more active, in consequence of which there is a more copious supply and deposition of the muscular fibre.

The strength of the voluntary muscles of young animals is not so great as those of animals that are older: thus, young horses of three years old are not capable of performing the labour of those of six or seven years, setting aside entirely the effect of work, and taking horses of these different ages, that have been similarly treated: hence weight for age is given at races.

In order to form an estimate of the great strength of the muscles of the living body, it is necessary to examine with attention the manner in which these are inserted into the bones, and near to the joints; for their mechanism may be understood from the properties of the lever.

Most of the muscles are so disposed as to act with a mechanical disadvantage, being inserted into the bones near to the joints, and at an acute angle; they are levers of the third kind, situated between the fulcrum and the resistance.

But this loss of strength is fully compensated by the *velocity with which they act, and the extent of motion they produce;* for it is more useful to us to move a moderate weight with due expedition, and with a considerable sweep, than to possess the power of raising a much greater weight more slowly, and through smaller space. It may be added, that the

short contractions of the muscles, which may be often repeated, create less fatigue than a longer contraction.

By this contrivance, which is also conducive to the elegance and symmetry of the body, *there is a sacrifice of force to attain velocity.*

Thus, the insertions of the *biceps flexor cubiti*, and *brachialis internus*, are at an average not more than an inch and a half distant from the elbow-joint, the fulcrum on which the fore-arm moves; and therefore a weight placed in the hand, is at a distance eight times greater from the elbow-joint: hence, if 50 lb. can be raised on the hand, it is with a force with which 400 lb. conld have been raised, had the muscle been applied to the extremity of the hand.

Further, as the biceps and brachialis internus pull their origins downwards, with as much force as their insertions upwards, it is evident, that if we suppose these muscles to be thrown over a pulley, they could raise 400 *lb. at each end, or in all* 800 *lb.*, a weight which would certainly have torn these muscles in a dead person; so prodigious is the difference between the strength of the muscles in the living and the dead.

In the living body, by a sudden exertion, the *tendons* are more frequently lacerated than the flesh; but in the dead body, *the belly of the muscle* is generally torn; and I have observed, that when the inferior extremities had not been laid straight after death, as in the bodies of persons that had been hanged, and had become rigid in that bent posture, the muscles were torn by extending the limbs; and the rigidity which had taken place must probably have shortened and fixed all the fleshy fibres equally, so that we can scarcely suppose that one fibre was torn after another.

It has been attempted by Mr Graham, Dr Desaguliers, Mr Le Roy, and Mr Regnier *, to calculate, by means of a spring steel-yard, the force of muscles of animals and men,

* Vide Experiments made with Regnier's spring steel-yard, or dynamometer, by Peron, in order to compare the strength of Europeans with that of the inhabitants of New Holland and the adjacent islands.—*Peron's Voyages.*

the natural strength of which probably depends upon the number of fibres which enter into their composition; but when we consider that one man is stronger than another in the legs, whilst another is stronger in the hands, and a third can lift a much greater weight,—the effect of habit in giving strength, mobility, and dexterity in the use of particular muscles, and the astonishing muscular efforts which delicate women are capable of making during a paroxysm of hysteria or mania, and the sudden and great degree of debility occasioned by fear, the insufficiency of such calculations appears obvious, being applicable to individual cases only. There are, besides, various causes, which I shall enumerate, which tend to diminish the force of the muscles.

The causes which tend to diminish the force of muscles are,

1*st*, Half the power is exerted on a fixed part of the body.

2*d*, When muscles act in concert, they do not act in the same line; hence the force must be as in the diagonal, and thus the muscular contraction is divided between different muscles, and fatigue of any particular muscle is avoided.

3*d*, A great source of loss of power results from the obliquity of the insertion of a muscle into the bone which it is intended to move.

4*th*, Perhaps there may be another cause of loss of power, owing to a muscle passing over two joints, where a considerable part of its force is expended in pressing one bone against another at the articulation.

5*th*, From the muscles being parallel to the bones they move, there must be a great loss of power.

6*th*, In consequence of old age the muscles lose a proportion of their contractile power; thus old people stand with their joints bent, the extensor muscles having lost a certain proportion of their contractile power.

7*th*, The fleshy fibres of a muscle are so disposed with respect to the tendon, as not to act in a line with it: hence a very great loss of power; and, in like manner, the general obliquity of the muscular fibres also produces, as in the penniform muscles, a great loss of power.

It merits mention, also, that the loss of power arising from the position of the muscles, and manner in which their tendons are fixed into the bones, is in a degree counterbalanced by the multiplication of the fibres of the muscles, by the increased diameter of the extremities of the bones, and by the introduction of moveable bones, as the *patella* and *sesamoid bones*, which alter the direction of the muscles, and increase their power.

The strength of muscles is also much lessened by the influence of passions of the mind, as that of fear, which unnerves the strongest arm.

Of Oblique Muscles.

There are many *important advantages gained by the oblique course of the fibres of the muscles*, which are fully explained in the subjoined pages on that subject, which I have extracted from my Father's Essay on the Oblique Muscles *.

Of the Varied Direction of the Fibres of our Muscles, and of the Effect of this upon our Motions.

I. In many of our muscles, the fleshy fibres, instead of running in straight lines, or in lines nearly such, between their origins and insertions, are placed in oblique directions.

Before I attempt to explain the effects of the direction of the fleshy fibres, I shall describe the varieties of this in the different muscles of the human body.

1. In some muscles, as in the recti of the abdomen, the sartorius, the gracilis, &c. the fibres are directed, from the origins of the muscles to their insertions, in nearly parallel lines; and these may be called *straight* muscles.

2. In others, the muscle is of a triangular shape, and its fibres resemble the spokes of a wheel, or the sticks of a spread fan; and such muscles may be called *radiated*. The fibres, in some of them diverge from the origin or fixed point, as is the case in the levator palpebræ superioris; and in others, as

* Edin. Phil. Trans. vol. iii.

in the temporal, subscapularis, or great pectoral, they converge from their origins towards their insertions.

If the edges and middle parts of such muscles are in the same plane, they co-operate, of which the temporal and trapezius may be examples. But, in others, as in the deltoid, the fibres are not in the same plane, but inclose a joint, and its oblique sides may be antagonists to its middle in one posture of the arm, viz. its hanging posture, but may co-operate with it when the arm is elevated.

3. In many muscles the fibres are parallel, or nearly so, to each other, but are laid obliquely between tendinous membranes, or between a bone and a tendinous membrane; and as their fleshy fibres resemble, in their direction, the plumage on one side of the stalk of a feather, they have been called *semipenniform* muscles. The flexors and extensors of the whole hand or foot, and the flexors and extensors of the fingers and toes, furnish striking examples of this kind of structure.

4. In some places the fleshy fibres run from both sides obliquely downwards, or obliquely upwards, to a tendon in the middle of the muscles, resembling, in their direction, the plumage on both sides of the stem of a feather; and, hence, such are called *complete penniform* muscles. The flexor longus pollicis pedis (see ALBINUS) is an example, in which the fibres descend; and the rectus extensor cruris an example in which they ascend, from the sides of the muscle to the middle tendon. When we compare a complete penniform muscle with a semipenniform muscle of the same breadth and thickness, as the number of its fibres is double, its strength will also be double to that of the semipenniform muscle.

5. We may next observe a combination of semipenniform muscles in the extensors of the fore-arm or leg, or *compound semipenniform* muscles.

6. In the soleus, we find a combination of complete penniform muscles, or a *compound penniform* muscle.

7. In many other places we find oblique muscles co-operating, although they are not joined to each other by common tendons; as is the case of the two rows of intercostal muscles;

and in many of those which are fixed to the head and spine. The sterno-mastoid, splenii, complexi, semi-spinales, multifidus spinæ, are all of them evidently of that description.

II. In many instances the obliquity of the fleshy fibres is so great, that the fibres are very much shorter than if they had run directly from what is called the origin of the muscle to its insertion, or the fibres are much more numerous than if the same space had been covered by straight fibres. Thus, suppose a straight muscle to be fifteen inches long, and that this is cut transversely into five equal parts, and these laid obliquely, in such a manner, as that their fibres form the diagonals of triangles, of which the height measures four inches, and the basis three inches. If there was no loss of strength by their pulling obliquely, the five short muscles would raise five times the weight; but, in fact, one-fifth of the force is lost, by their obliquity. Borelli, De Motu Musculorum, p. 92., proves, That the "potentia oblique trahens est ad resistentiam ut longitudo directionis oblique ad ejus sublimitatem." But after this deduction, the five oblique muscles could raise four times as much as the single straight one of the same breadth and thickness.

III. From the increase of strength which many muscles gain, by having their fibres made shorter, though laid in an oblique direction, it was universally supposed by authors, that the increase of force was the *only* purpose served by the obliquity of their fibres.

IV. Other very different purposes are served, by the obliquity of the fibres of muscle. In various instances, the strength of the muscle is diminished by the obliquity of its fibres, as that of many of the short muscles attached to the spine; as in the semi-spinalis colli et dorsi, multifidus spinæ, &c.

The most striking instance of this is to be found in the intercostal muscles. For it is evident, that if their fibres had been straight or perpendicular to the ribs, they would have

been not only much more numerous than in the oblique position, but would have acted upon the ribs with greater force.

In all these instances, one reason of the diminution of force is, that the oblique muscles are longer, and therefore have fewer fibres than straight ones supposed to fill the same space; and the other reason is, that a muscle loses force by pulling obliquely, in the proportion which its length bears to the length of the sine of the angle which it forms with an horizontal line, or to the length of a perpendicular joining two horizontal lines which pass through the origin and insertion of the muscle. Thus, if an oblique muscle deviates one-half of a right angle from the perpendicular, it loses the one-half exactly of its strength.

In all examples, where a space between two parallel lines or bones, such as the ribs, is filled up with muscular fibres, there will be a greater number of fibres when they run transversely than when they are placed obliquely, and they will besides act with more force: And, even when we suppose the number of fibres in two muscles so situated to be equal, the muscle with straight fibres will be stronger than the oblique one, in the proportion exactly which the length of the oblique fibre bears to the straight or perpendicular one.

Hence, in all such cases, some advantages very different from an increase of strength must be gained by the obliquity.

V. It may easily be proved *, that a pair of oblique muscles placed between the same parallels with a pair of straight muscles, can, with less proportional decurtation, produce the same extent of motion that the straight muscles can do; and also that the oblique muscle has not lost so much of its length as is equal to one-third of the length of the straight muscle; and that the oblique muscle, after bringing its insertion to the same point as the straight muscle had done, has not lost so much of its length as the straight muscle had lost.

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* See proofs, in Outlines of Anatomy, Vol. I. p. 111., 112.

VI. Farther, two oblique can produce a more extensive motion than two straight muscles of the same length, and which, at first sight, seem much better fitted for the purpose.

VII. On the same principles, the extent of motion increases with the degree of the obliquity of the muscles; and, as the degree of obliquity of an oblique muscle is gradually increasing during its action, its force is diminishing, whilst its effect of producing extensive motion is increasing.

VIII. The general proposition may be proved by arithmetical calculation. Thus if we suppose two straight muscles, such as our recti abdominis, to be five inches long, and to shorten themselves, in contracting, one-fifth part of their length, they will draw the ensiform cartilage through a space of one inch only; but if we suppose the same muscles to be placed obliquely, and their origins fixed to the ossa ilia instead of the ossa pubis, and that a line drawn transversely between the ossa ilia measures eight inches, it is evident that they would draw the ensiform cartilage three times farther, because they will not lose one-fifth of their length till the ensiform cartilage is brought down to the middle of the line that is drawn between their origins. Let us next suppose two muscles, each 13 inches long, to be laid so obliquely, that a line drawn perpendicularly from their insertion to the middle of a line joining their origins, measures 5 inches. If these muscles shorten themselves a single inch, the place of their insertion will be moved through a space of 5 inches, or five times farther than it could be by the action of two straight muscles.

IX. Upon the whole, oblique muscles have the following effects.

1. Although the force of an oblique muscle is less than that of a straight one of the same number of fibres, in the proportion which the perpendicular bears to the length of the oblique fibre, yet oblique muscles, with short and numerous fibres, are employed where great strength is necessary, as in bending the fingers or toes; or where the part to be moved, the hand

or the foot, we shall suppose, resists, with the advantage of a long lever, against the muscles which serve for the flexion and extension of the elbow or knee; because, as a small degree of decurtation of the muscles is sufficient, short fibres will answer the purpose as well as long ones; and hence, as in such oblique muscles there may be many more fibres than in longer straight muscles occupying the same space, the oblique are preferred. This resource of nature is so important, that, on recollection, you will find that there are more oblique than straight muscles in the human body, and in the bodies perhaps of all other animals; or that, in the greater number of muscles, the fleshy fibres are shorter than the direct length between the tendons at their extremities, or between the origins and insertions of the muscles. And the number of oblique muscles is still greater in fishes and aquatic animals, as a greater force is necessary to overcome the resistance of water than that of air.

2. When oblique muscles, consisting of the same number of fibres as straight muscles, are placed between two parallel lines, or between bones or other substances, which, when they are moved, remain parallel to each other, or nearly so, although their loss in strength be exactly in the proportion which their length bears to the direct distance between the parallel lines, yet we have found that they are capable of performing a much more extensive motion with the same proportional decurtation of fibres, or a motion of the same extent with less decurtation of fibres. Nay, that they are capable of bringing the parallel lines into contact with each other, which it is evidently impossible could be done by straight muscles.

The most striking instance of this kind is found in the intercostal muscles; for, in this part of the body, nature, for the defence of the heart and lungs, forms the ribs as broad, and the spaces between them as narrow, as is consistent with their safety. Hence straight or perpendicular muscles between the ribs would not have had sufficient length for producing the proper motion of the ribs; and we even find, that a great degree of their obliquity is required to produce sufficient motion.

In this part of the body we may remark another beautiful application of oblique muscles; for we find a second row of

oblique intercostal muscles within the first, serving two material purposes, viz. in the *first* place, That this row compensates for the loss of strength the first row has suffered by its obliquity; and, in the *next* place, That the two rows conspiring, raise the ribs as directly upwards as could have been done by straight muscles, and press them as little forwards or backwards against their articulations as these would have done *.

In various other parts of the body, but particularly in the spine, where there are many joints, and the pieces of bone and intermediate cartilages are thin, straight muscles must have been so short, and their power of contraction so small, that they could not have produced a sufficient degree of motion in the joints of the spine; and hence we have found, that oblique muscles are very generally substituted instead of them.

As I have demonstrated that oblique muscles can perform the same extent of motion as straight ones, not only with a smaller proportional, but with a smaller actual, decurtation of their fibres; and, of course, that when they are contracted to the same proportional or actual degree, their motions are more extensive; we may observe, in many cases, where an increase of strength is chiefly intended by the obliquity of the fibres of the muscles, that they are employed also for increasing the extent of motion. Thus the upper and lower portions of the trapezius muscle, or the two lateral portions of the deltoid muscle co-operating, can produce more extensive motion of the scapula and of the humerus than could be done by the middle portions of these muscles. In like manner, the external and internal oblique muscles of the abdomen co-operating, appear to be capable of bending the thorax forwards in as great a degree as can be done by the recti, although their fibres are considerably shorter.

4. As the oblique muscles can, with a smaller degree of decurtation, perform the same extent of motion as a straight

* This *latter* circumstance was distinctly remarked by Dr Mayow, De Respiratione, p. 247, and proved experimentally by Dr Haller.

one, it follows, that the same motions performed by them, will be executed in a shorter space of time than could have been executed by straight muscles of the same length, provided we take for granted that the time in which the action of a muscle is completed bears a proportion to the length of the muscle. To support, in some measure, this supposition, we may observe, that similar actions of small animals are completed sooner than those of larger; or, if we compare the action of the multifidus spinæ, which we may suppose to consist of as many short muscles as there are true vertebræ, with the action of a single straight muscle, supposed to reach from the os sacrum to the head, it is evident, that each of the several insertions of the multifidus spinæ would, in the same times, be moved through one twenty-fourth part only of the space through which the insertion of the single long muscle must pass; and, therefore, unless we suppose the insertion of the long muscle to move twenty-four times more quickly than each of the insertions of the multifidus, it could not, in the same time, extend the trunk of the body to the same degree.

5. As the oblique muscles, in performing the same motions as straight muscles might perform, are less shortened than the straight would be, there is a saving of motion, and hence probably less fatigue.

6. Two oblique muscles, by balancing each other, may produce motions in a greater variety of directions than can be done by a pair of straight ones.

In the first place, by acting singly and alternately, they perform the offices of straight muscles, and draw alternately the place of their insertion directly towards its origins, which are generally more distant from each other than the origins of two straight muscles.

If, next, they co-operate with equal strength, the place of their insertion is moved in the diagonal between them, as when the oblique muscles of the abdomen draw the ensiform cartilage towards the ossa pubis.

7. In the last place, each of them may act with different degrees of force, and hence move the place of their insertions in all the diagonal lines we may suppose to be drawn between

them; or we may compare the pair of oblique muscles to the outer sticks of a spread fan, and the variety of the directions of the motions they are capable of producing, to the co-operations of intermediate sticks of the fan. In consequence of this motion in diagonal lines, the four recti muscles of the eye-ball enable us to follow an object moving before us in a circle.

Antagonist Muscles.

In a former page, it was observed, that there were antagonist muscles, Flexor and Extensor muscles, which act by an opposite pull. Such a disposition of the muscles is conducive not only to the reciprocal energetic motion of the limbs, but also to their symmetry. Thus after the flexor muscles of the fore-arm have bent it, the extensor muscles act, and extend and straighten it. The flexor muscles are generally stronger than the extensors, owing to their fibres being more numerous, and to their being inserted further from the centre of motion: hence, during sleep, the limbs are generally somewhat bent.

Velocity of Muscular Action.

The velocity and precision of muscular action are very remarkable; and of these there are many striking examples, as in speaking, writing, running, &c.

Effect of Custom on Muscular Action.

Custom exercises its sway over the muscles. The bladder of urine affords an example of the effects of custom. Some persons retain a large quantity of urine in it, but others have a call to make water when it contains only a few ounces of urine.

Effects of Imitation and Sympathy upon Muscular Action.

Imitation is a very useful agent in instructing us in performing many actions. Thus the child learns to speak, use its limbs, &c. In early life, it is equally independent of reason and reflection, and even takes place in direct opposition

to the will, as in yawning. All those actions which are necessary for life, as sucking, swallowing, or crying, a child performs accurately as soon as it is born; but others, which are less necessary, it gains by practice, or by being taught.

By *Sympathy*, particular muscles are called into action. Thus, the sight of disagreeable objects produces the expression of horror, and sometimes excites vomiting; and perhaps, owing to this principle, hysteria and epilepsy are propagated from one person to another.

Effects of Passions of the Mind on Muscular Action.

The different passions of the mind naturally call into action certain muscles, and the predominating passion implants upon the countenance a corresponding indelible impression, though the mind is not at the instant under the influence of that particular passion: hence, those of the same profession generally acquire the same character of countenance. Upon this the science of Physiognomy is built. Not only the muscles of the face, but also those of other parts of the body, are thrown into actions corresponding with the ruling passions of the mind.

The attitude of the body is perhaps equally characteristic of particular passions as the expression of the countenance. To this the painter must devote particular attention, that the attitude of the figure be consonant with the expression of the face.

The last circumstance respecting muscles which merits mention is, the wonderful manner in which muscles, in cases of fractures and luxations, adapt themselves to their unnatural situations. This is a process of time; for, at first, the ill-set bone, or dislocated joint, is in a great measure motionless; but, in process of time, a certain degree of the power of motion is regained, and even when the fractured limb has been rendered considerably shorter than the sound limb, and when the muscles must have lost considerably of their length.

Vide many other observations upon muscular action, under the head of Functions of the Nervous System.

Authors on the Structure and Action of Muscles.

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Muys, Muscul. artific. fabrica, Leyd. 1741.
Winslow, Traité des Muscles.
Albini Historia Muscul.
Prochaska, De Carne Musculari, Viennæ, 1778.
Borelli, De Motu Musculorum.
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Barthez on the Mechanism of the Muscles.
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SECTION II.

GENERAL OBSERVATIONS ON THE BURSÆ MUCOSÆ, VESICÆ UNGUINOSÆ, OR BURSÆ SYNOVIALES.

The term *Bursa Mucosa* was applied by Albinus to certain shut sacs, which he discovered placed under the tendons of the muscles. Albinus has enumerated only 16 pairs of these, not being aware that tendons within sheaths were provided with similar, but oblong-shaped bursæ. My Father discovered many of the bursæ, and has described, in his Treatise on these shut sacs, 140 of them; and since he published, several small bursæ have been discovered in the head, neck and trunk of the body, which have been described and delineated by Dr Rosenmuller of Leipsic.

The bursæ mucosæ are of different sizes in different parts of the body, and in proportion to the bulk of the body, are larger in a child than in an adult, and are interposed between such parts as rub violently upon each other. They are connected by cellular substance to the capsular ligaments, muscles, and their tendons, in such a manner as to lessen the effect of attrition.

1*st*, The bursæ are situated between bones,—as between the clavicle and coracoid processes of the scapula.

2d, Between bone and ligaments,—as between the acromion and ligaments of the humerus.

3d, Between tendon and ligament,—as between the tendon of the psoas, iliacus internus and ligament of the hip-joint.

4th, Between two tendons,—as between the tendons of the extensores carpi, longior and brevior.

5th, Between tendon and its sheath,—as within the sheaths of the tendons of the fingers and toes.

6th, Between tendon and cartilage,—as between the tendon of the superior oblique muscle of the eye, and its cartilaginous pulley.

7th, Between tendon and bone,—as between the tendon of the scapulo-radialis muscle and radius, &c.

The bursæ are larger in the extremities than in the trunk of the body, and are either of a rounded or oval shape, or somewhat like purses, including the sheaths of the tendons: hence the bursæ have been arranged under two great classes, the *Spherical* and the *Vaginal Bursæ*.

The proper membranes of the bursæ, though remarkably thin, are capable of confining fluids, and even air; and, according to my Father, are in structure similar to the internal layer of the *capsular ligaments of the joints, to the pleura, periosteum, and other serous membranes*, and consequently, subject to the same organic derangements *.

The membranes of the bursæ are united to the neighbouring parts by the common cellular membrane, and where situated in the vicinity of the bones, a thin layer of cartilage is interposed between the bursa and the bone.

The membrane of the bursa is internally remarkably smooth, and lubricated by *a fluid in all respects similar* to synovia, and there are very small masses of fat within the bursa, with fringes appended to them, which are covered by the continuation of the membrane of the bursa, and upon which the smaller ramifications of the arteries are distributed

* In this observation he has anticipated Bichat.

in considerable number, which thereby communicate to it a pale red colour.

Lymphatic Vessels.

Lymphatic vessels certainly are proper to the bursæ, but they are so small as to elude observation.

1*st*, If the bursæ mucosæ had not been provided with lymphatic vessels, they must have been much distended, and at length ruptured by the quantity of fluid accumulated within them.

2*d*, Fluids of different descriptions, which are occasionally collected within the bursæ, have been sometimes resumed.

Nerves.

On account of the extreme thinness of the coats of the bursæ mucosæ, the anatomist cannot give ocular proof of nerves being distributed upon their coats, which has given rise to the opinion, that the bursæ mucosæ are not supplied with nerves, which opinion, as the bursæ are endowed with little sensibility, has gained weight. But as an inflammation of the bursæ occasions great pain, there can be no doubt *of their being under the influence of nerves.*

Authors upon the Bursæ Mucosæ.

Winslow, Exposit. Tr. des Os frais, 286.

B. S. Albinus, vide Histor. Muscul. 4to, 1754, p. 694.

Sandifort, Descr. Mus. Hominis, 1781.

Monro's Description of all the Bursæ Mucosæ of the Human Body, fol. Edin. 1788.

Professor Sœmmering, one of the most distinguished anatomists of Germany, has stated his opinion of this last book in the following terms : " Omnium optimum opus, icones descriptarum bursarum magnitudine naturali, ut uno quasi intuitu earum positus, figura et magnitudo comprehendi possint, quod sola descriptione nunquam effici potest."—Vide Catalogue of Authors, prefixed to the third volume of his Anatomy.

CHAP. II.

OF THE PARTICULAR MUSCLES.

SECTION I.

OF THE MUSCLES OF THE HEAD AND NECK.

There is considerable difficulty in exposing these muscles, as they are thin, mixed with fat and cellular substances, incorporated with each other, and attached to the skin.

On the forehead is seen the frontal part of the *Occipito-Frontalis Muscle;* and a small part of that muscle which descends to the root of the nose.

At the side of the head, there is a thin muscle which raises the ear, and covers the temporal muscles; and before the ear, a small muscle, which pulls the ear forwards; and around the eyeballs, the muscle called *Orbicularis Palpebrarum* occurs.

On the cartilages affixed to the bones of the nose, and which form the Alæ Nasi, a few thin scattering fibres are placed, which form a muscle, called, from its office, *Compressor Narium.*

Arising from the side of the nose, and superior maxillary bone, there is a thin muscle passing down to be fixed into the upper lip, and which has been named, from its office, *the Levator Labii Superioris Alœque Nasi.*

There are three small muscles which pass obliquely downwards and inwards, to be fixed to the corners of the mouth. Two of these have been named, from their origins from the Zygoma, *Zygomatici;* and the third has been named, from its office, *Levator Anguli Oris.*

There is a triangular-shaped muscle which arises from the side of the chin, and which is fixed into the corner of the mouth, which has been named, from its office, the *Depressor Anguli Oris.*

There is a muscle of the figure of an oblong square (which is in part covered by the under part of the preceding muscle), which ascends from the chin, and is fixed into the under lip, and has been named, from its office, *Depressor Labii Inferioris.*

The two last muscles are in part covered by a few thin muscular fibres of a thin muscle of the neck called the *Platysma Myoides.*

There are a few fibres passing transversely from one platysma myoides to the other, which have been described by SANTORINI under the name *Transversus Menti.*

The muscular fibres which pass around the mouth, and which have been said to form the Orbicularis, or Sphincter Oris, are also obvious.

Second Layer.

Under the portion of the *Occipito-Frontalis Muscle* which is fixed into the superciliary ridge, a small rounded muscle is placed, which is fixed into the middle of the superciliary ridge, which has been called *Corrugator Supercilii.*

The Temporal muscle is seen in the temples, and its tendon passing under the zygoma. A strong muscle, extending downward from the zygoma to the angle of the under jaw, called, from its very powerful effect in manducation, *Masseter*, is distinctly seen.

The muscle called *Buccinator*, extending between the *Masseter* and *Orbicularis Oris*, is seen; the fat, and that part of the parotid gland which covered it, being removed.

Under the Levator Labii superioris, there are a few scattered fibres, which SŒMMERING has noticed (vide his third volume, p. 102.) as a muscle, under the name of *Musculus anomalus Maxillæ superioris.*

The *Levator Anguli Oris* is now seen arising from the superior maxillary bone, and fixed into the corner of the mouth.

Third Layer.

In this third layer, ALBINUS has represented the insertion of the muscle which draws the eye-ball towards the nose, and

which therefore has been called *Adductor Oculi.* The insertion of the muscle which raises the eyeball, and which has therefore been called *Levator Oculi*, and the *Obliquus Inferior Oculi*, are also imperfectly seen.

Occipito-Frontalis Muscle.

The occipito-frontalis muscle consists of two distinct parts, an anterior and posterior, which are united by a thin tendinous membrane. This membrane covers each side of the skull, as low down as the attollens aurem, to which it is fixed, and also to the zygoma, and it covers a part of the aponeurosis of the temporal muscle. The muscular stratum in front takes its rise from the superciliary ridge of the frontal bone, and that behind, from the transverse ridge of the os occipitis. A small portion of the anterior part of this muscle is fixed into the internal angular process of this bone, and into the root of the ossa nasi. This muscle corrugates the skin of the head, throws the forehead into wrinkles, and raises the eyebrows.

The muscles proper to the ears, nose, and eye-lids, are described at the same time as the organs to which they are affixed.

Muscles which move the Lower Jaw, and which are subservient to the Mastication of the Food.

The under jaw is elevated and moved laterally by the Temporo-Maxillaris inferior, the Jugo-Maxillaris, and the Pterygoid muscles.

The power of these muscles is very great, even in the human body, of which many striking examples are to be found in the works of VESALIUS and HALLER. In carnivorous animals, these muscles are of a much greater thickness and strength.

Temporo-Maxillaris Inferior, or *Temporal Muscle.*

This muscle is covered by the tendinous aponeurosis of the occipito-frontalis muscle, by the attollens aurem, and by the superficial temporal artery, veins and nerves.

The Temporal Muscle takes its origin from its Aponeurosis, and from the Temporal Fossa, formed by the Os Frontis,

Temporis, Sphenoides, Malæ, by radiated fleshy fibres, which, as they descend, become gradually thicker, and which pass under the zygoma, filling up the space between it and the temporal bone; and also from the inner surface of the zygoma.

This muscle is fixed into the coronoid process of the under jaw, by the medium of a tendon which envelops the coronoid process.

The muscle is covered by a thick tendinous aponeurosis, which is connected with the temporal ridge, the superior edge of the zygoma, and outer edge of the orbit.

The above muscle elevates the under jaw; but it may act with its anterior or posterior fibres in drawing the under jaw backwards or forwards.

Zygomato-Maxillaris, or *Masseter*.

To expose fully to view this muscle, it is necsssary to remove the platysma myoides, the parotid gland, the nerves of the face, and the transverse artery of the face, and a portion of the orbicularis palpebrarum muscle.

This muscle forms a distinct prominence between the forepart of the ear and angle of the lower law.

It is a thick, strong muscle, of an oblong square shape, which covers and deeply imprints the side of the under jaw-bone.

It takes its origin from the superior Maxilla, and from the Zygoma, by tendinous fibres; and is fixed into the side and angle of the under jaw.

The fibres of the different parts of this muscle cross each other; the outer part slants backwards, and the inner part forwards, so that the fibres in a degree decussate one another.

This very strong muscle concurs with the former in elevating the under jaw.

The outer part of it also assists in pulling the jaw forwards, and the remainder of the muscle pulls the jaw backwards.

The lateral movements of the under jaw are performed by the Pterygoidei muscles.

The Pterygo-Maxillaris Minor, Superior, or Pterygoideus Externus,

Takes its rise from the outer side of the Pterygoid Plate

of the Sphenoid bone, from the tuberosity of the superior Maxillary bone, and from the root of the Temporal process of the Sphenoid bone; and it passes horizontally, and is fixed into the neck and capsular ligament of the under jaw.

This muscle pulls the jaw laterally; and if it be thrown into action with its fellow, the jaw is pulled forwards, by which the fore-teeth of the under jaw project before those of the upper jaw.

Pterygo-Maxillaris Major, Inferior, or Pterygoideus Internus.

This muscle takes its rise from the Fossa Pterygoidea of the Sphenoid bone, and from the Palate bone, and is fixed into the inner side of the angle of the under jaw, being placed nearly opposite to the Masseter muscle, to which, in figure, it bears some resemblance.

This is a powerful muscle in masticating the food; it gives the lateral motion of the jaw; and, when thrown into action, in conjunction with its fellow, the jaw-bone is elevated.

Mastoido-Mentalis, or Digastricus.

This is a double muscle: one part of it arises from the groove at the root of the Mastoid process of the Temporal bone; and, descending obliquely downwards and inwards through the fibres of the Stylo-hyoid muscle, it is connected to the Os Hyoides by a thin ligament. It then passes obliquely upwards and outwards at an obtuse angle, and is fixed into the middle of the lower jaw at its lower part.

By this muscle, the mouth is opened; and when the jaws are shut, the Os Hyoides is drawn towards the under jaw; and the posterior part of the muscle draws the Os Hyoides towards the Mastoid process of the Temporal bone.

Dr Soemmering has stated, that if the lower jaw be fixed, this muscle tends to depress the back of the head upon the spine, and thereby to open the mouth, by elevating the upper jaw: this he states he has observed while a child is sucking. —There are some of the muscles which are fixed to the Os Hyoides, and under jaw, and also to the thorax, as the Platysma Myoides: But as these muscles are subservient to other purposes, they shall be mentioned in another place.

Muscles of the Cheeks and Lips.

There are ten muscles which are proper to the lips and cheeks.

These muscles in the human body, are capable of a greater variety of action than in brutes.

The carnivorous animal has muscles for shewing its teeth, and for raising that part of the upper-lip which covers the canine teeth; but, in a graminivorous animal, the lips are fixed down on the fore-part of the gums, where only that part of the lips which is over the front teeth can be elevated; hence the difference of expression of a graminivorous and carnivorous animal; the former shews his teeth, the latter snorts.

The muscles of the human face are susceptible of the action of carnivorous and graminivorous animals.

The muscles of the human face are disposed in pairs, so that the action of the one side counterpoises that of the other; hence, when one side loses its power, as in palsy, the corner of the mouth is drawn up. The greater number of muscles of the human face are fixed to the inner corner of the eye-brow, or inner corner of mouth, which, therefore, are the most expressive parts of the human countenance.

The Labialis, or Orbicularis Oris.

This muscle lies immediately below the skin, and between its fibres there is a good deal of fat.

The fibres of this muscle, which are small, decussate each other at the corners of the mouth; so that this muscle seems to consist of two semicircular muscles; and they arise from the several muscles which are united at the corner of the mouth.

The outer part of the muscle is formed of the fibres of all the Levatores Labii Superioris and Zygomatici; but the fibres of the several muscles are so intermixed with each other, that it is impossible to distinguish the one from the other.

The internal fibres form the true Sphincter Oris.

This muscle shuts the mouth: it brings the lips into contact with each other, or with any substance put into the mouth,

as in the act of suction, and is the antagonist of the greater number of muscles of the mouth.

A part of this muscle forms the Nasalis Labii Superioris of Albinus.

This muscle possesses a very extensive sphere of action; for it may be contracted and corrugated to such an extent, as to embrace a pin; and it may be expanded, so as to admit all the fingers. The external part of this muscle tends to turn the lips inside out, or to shew the red part of the lips.

Zygomato-Labialis Major and Minor, or the Zygomaticus Major and Minor.

These are thin and small muscles, which descend obliquely downwards and inwards, to the corners of the mouth. They arise from the convexity of the Os Malæ, descend obliquely forwards, and terminate in the corner of the mouth, where their fibres are incorporated with those of the Depressor Anguli Oris.

When the muscles of opposite sides act at the same time, they draw the corners of the mouth outwards, as in laughing; and if one of these muscles only be thrown into action, the corner of that side of the mouth is drawn upwards.

The lesser zygomatic muscle is frequently awanting.

Super-Maxillo-Labialis Major et Medius, or the Levator Labii Superioris Alæque Nasi.

This muscle arises from the nasal process of the upper jaw, and descends along the groove for the lacrymal sac: it also arises from the external part of the orbitar process of the same bone, which forms the lower part of the orbit immediately above the passage for the infra-orbitar artery, vein and nerve. The muscle is fixed into the Ala Nasi, where it is united with the Compressor Narium, and into the upper lip. This muscle raises the upper lip, and the ala nasi, and thereby dilates the nostril.

The Super-Maxillo-Labialis Minor, or the Levator Anguli Oris.

This muscle is covered by the preceding. It arises from

the depression of the upper jaw-bone, immediately below the Foramen Infra-orbitarium; and it passes obliquely downwards, and outwards, to be inserted into the corner of the mouth.

The Maxillo-Labialis Inferior, or the Depressor Anguli Oris.

This flat and triangular shaped muscle, which is very various in point of size, in different individuals, arises from the side of the under jaw; crosses the lower part of the Depressor Labii Inferioris, and, becoming narrower as it ascends, unites in the corner of the mouth with the Zygomatic and Levator Anguli Oris.

It depresses the corner of the mouth, as in crying.

The Mento-Labialis, or Depressor Labii Inferioris.

This muscle arises from the anterior, but chiefly from the lateral, part of the under jaw.

The fibres of this muscle pass obliquely upwards and inwards, till it joins its fellow in the middle of the lip; and is fixed by a broad plate of muscular fibres into the under lip.

This muscle opens the mouth, by depressing the under lip.

Levator Menti, or Levator Labii Inferioris,

Arises from the alveolar processes of the incisor and canine teeth of the lower jaw, and terminates in the under lip and skin of the chin.

The use of this muscle is to raise the under lip when it has been depressed; and it also corrugates the chin, and turns outwards the lip.

Depressor Labii Superioris et Alæ Nasi.

This small muscle arises from the alveolar processes of the incisor and canine teeth of the upper jaw; and it is fixed into the upper lip and root of the wing of the nose.

This muscle draws the upper lip downwards.

Bucco-Labialis, or Buccinator.

This thin and quadrangular portion of flesh covers the mu-

cous membrane of the cheek, and occupies the space between the upper and under jaws, and is covered by a considerable quantity of fat.

It arises from the pterygoid process of the sphenoid bone, side of the pharynx, and from the space between the last grinder and coronoid process of the lower jaw. The fibres of the muscle are transverse in respect to the face; and they terminate in the orbicularis muscle in the corner of the mouth.

This muscle draws the angle of the mouth backwards, and corrugates the cheek; hence is employed in expelling the contents of the mouth, or in blowing wind instruments; and it is also employed in pressing the cheek inwards, and in putting alimentary substances between the teeth.

Muscles of the Palate.

These are described together, with the other parts of the palate.

DISPOSITION OF THE MUSCLES OF THE FORE-PART OF THE NECK.

First Layer.

Upon removing the skin and cellular substance of the fore-part of the neck, a thin tendinous membrane presents itself, which is the continuation of the same fascia which covers the muscles of the abdomen. This fascia ascends upon the face, and is slightly connected with the base of the under jaw; and it is ultimately inserted into the zygoma and mastoid process of the temporal bone. There is a thin and broad muscle, which covers the greater part of the side and fore-part of the neck; a part of the side of the face; and a portion of the upper part of the chest; and which has been named *Platysma Myoides.*

Under this tendinous fascia the fibres of this muscle, in a robust subject, are conspicuous; but in the aged and thin, it is composed of very thin and pale fibres, which are disposed irregularly over the side of the neck. The fibres of this muscle pass obliquely upwards, and are lost upon the side of the face.

Mr A. Burns * has most justly observed, "From the resistance afforded by the platysma myoides and the fascia, such tumours penetrate between the contiguous muscles, and encircle the subjacent vessels and nerves, rendering, where the disease is advanced, the excision of these swellings peculiarly perplexing to the surgeon, and dangerous to the patient. Indeed, there are many tumours formed in the region between the chin and the chest, to attempt the removal of which, would, on the part of the operator, betray the grossest ignorance of the structure of the neighbouring parts. Some tumours are so deeply attached to the pharynx, are so intricately entangled among important arteries and nerves, and so firmly fixed to the muscles in the vicinity, that to undertake their extirpation would be to form the resolution to injure all these parts.

"This establishes most forcibly the propriety, nay, it proves the absolute necessity, of as speedy a removal of the morbid parts, as is compatible with prudent attempts to remove the tumour without operation. If distant parts have suffered from an extension of the morbid action, no one can be certain that all the diseased substance has been cleared away; and if a single atom of the contaminated parts be permitted to remain, the patient is in a condition equally dangerous as before we operated. The disease is suspended, not eradicated, and the secondary affection is worse than the first."

Second Layer.

Under the platysma myoides, a strong muscle, extending obliquely upwards from the breast-bone, and collar bone, to be fixed by tendinous fibres into the back part of the mastoid process of the temporal bone, is seen, called *Sterno-Cleido-Mastoid Muscle.* The different portions of this muscle, from the sternum and collar bone, are united by cellular substance.

The sterno-cleido-mastoid muscle is a thick strong muscle, which arises by two heads, the one of which takes its origin

* Vide his Surgical Anatomy of the Neck, p. 18.

from the uppermost piece of the sternum, and the other from the sternal extremity of the collar bone. The two heads of the muscle are soon united, and form a thick muscle, with oblique fibres, which is fixed into the mastoid process of the temporal bone.

The relation of this muscle, in respect to the subclavian artery merits notice; it has been faithfully described by Mr A. Burns.

"The natural connections of these parts are best shown by merely raising the sternal extremity of the sterno-mastoid muscle. If this be done, the nervus vagus will be brought into view, lying on the fore-part of the subclavian artery, almost directly behind the sternal end of the clavicle, and exactly opposite to the nervus vagus; but behind the artery, the lower cervical ganglion of the sympathetic nerve will be brought into view. The recurrent nerve, on the right side, hooks round the subclavian artery, and in its course toward the larynx, ascends along the tracheal side of the sympathetic nerve. On the left side it twines round the arch of the aorta, and in mounting upward, is interposed between the subclavian artery, and the œsophagus. The subclavian vein lies anterior to the artery, and in the collapsed state, sinks nearer to the thorax.

"This is its usual position in the dead body, but in the living person its relation to the artery is constantly changing. Alternately it is flaccid and full; in the first state it bears the same relation to the artery as in the dead subject; under the latter circumstance it swells out quite tense, and ascends, so as in some measure, to overhang and conceal the artery. The thoracic duct enters the subclavian vein about an eighth of an inch nearer to the acromion than the point where the internal jugular vein empties itself into the subclavian vein. The termination of the thoracic duct is situated between the sternal and clavicular portions of the sterno-mastoid muscle.

"I have been thus particular in the description of the parts connected with the subclavian artery, between its origin and the scaleni muscles; because, one who knows their position, and is aware of their importance, will correctly estimate the

risk of attempting to tie the artery nearer to the heart than the scaleni muscles."

Covering a part of the trachea, may be seen the thin muscle arising from the breast-bone, and fixed into the os hyoides, called *Sterno-Hyoideus;* and, higher up the neck, a part of a muscle which has passed under the sterno-cleido-mastoid muscle, which, from its origin from the scapula, and insertion into the os hyoides, has been called *Omo-hyoideus.*

Third Layer.

By removing the above mentioned muscles, the thyroid and cricoid cartilages of the larynx are seen; and, covering the fore-part of the trachea, a muscle, which arises from the breast-bone, and is fixed into the thyroid cartilage of the larynx, and which has therefore been called *Sterno-Thyroideus;* and also a muscle which arises from the thyroid cartilage, and is fixed into the os hyoides, and which has hence been named *Thyro-Hyoideus.*

Disposition of the Muscles of the Os Hyoides and Tongue.

To get a distinct view of the muscles of the os hyoides and tongue, the head should be thrown back, in order to put these muscles upon the stretch.

First Layer.

Upon the skin, cellular membrane, and tendinous aponeurosis below the chin being removed, the following muscles come into view.

The anterior head of the *digastric muscle*, extending between the symphysis of the lower jaw and os hyoides, and the posterior head of the same muscle passing through the *stylo-hyoid muscle*, downwards and forwards, to be fixed to the os hyoides; and between the two heads of the muscle, the submaxillary gland is placed.

Second Layer.

Upon detaching the above named muscles, the thin and broad muscle, called *Mylo-hyoideus*, comes into view, extend-

ing between the os hyoides, and a considerable portion of the under-jaw.

The stylo-glossus muscle also comes into view arising from the styloid process of the under-jaw, and supported by its ligament, and passing downwards to be fixed into the tongue; and a little below that muscle, another muscle, taking its rise also from the styloid process, and passing downwards to the pharynx, called hence *Stylo-pharyngeus*, comes into view

Between the two preceding muscles and the *Mylo-hyoideus* muscle, there is the *Hyo-glossus* muscle, with its fibres passing nearly perpendicularly downwards to be fixed into the tongue.

A part of the constrictores pharyngis is also seen.

Third Layer.

Upon the preceding muscles being removed, the *Genio-hyoideus*, passing betwixt the symphysis of the under jaw and os hyoides, appears; and on the side of it, next the pharynx, (supposing the head to be viewed in profile), the *Geniohyo-glossus*.

MUSCLES FOR MOVING THE OS HYOIDES.

Maxillo-Hyoideus, or Mylo-hyoideus.

This thin, flat, and broad muscle arises from a ridge on the inner side of the jaw, which extends between the chin and last grinding teeth. The fibres pass obliquely forwards and downwards, to the symphysis of the jaw, and are fixed into the body of the os hyoides. There is a portion of tendon in the middle of the muscles, of opposite sides, extending from the symphysis of the lower-jaw, to the base of the os hyoides.

This muscle elevates the os hyoides; and, when the os hyoides is fixed, it may depress the under jaw.

Genio-Hyoideus.

This rounded muscle, which is placed under the former, passes from the symphysis of the under-jaw obliquely downwards and backwards to the middle of the basis of the os hyoides. By this muscle, the os hyoides is elevated, and drawn forwards towards the chin, when the jaws are shut.

Omo-Hyoideus.

This thin and flat muscle arises from the superior costa of the scapula. It ascends obliquely forwards and inwards; and, when under the sterno-mastoid muscle, it is tendinous; it again becomes fleshy, and is at length fixed into the lower margin of the base of the os hyoides.

This muscle draws the os hyoides obliquely downwards and backwards.

Sterno-Hyoideus.

This thin and flat muscle, which arises from the outer part of the uppermost bone of the sternum, from the first rib and from the clavicle, and covering the lateral surfaces of the trachea, is at length inserted into the middle of the lower edge of the basis of the os hyoides, near to the insertion of the omo-hyoideus muscle.

Sterno-Thyroideus.

This muscle is shorter and broader than the preceding muscles, and placed beneath the former, with which it has a similar origin. The jugular vein, the carotid artery, the trachea, the thyroid gland and its vessels, lie under this muscle.

The muscle terminates in the wing of the thyroid cartilage.

Hyo-Thyroideus.

This muscle is the continuation of the preceding; it arises from the wing of the thyroid cartilage, and ascending, is fixed to the base and cornu of the os hyoides.

This, like the preceding muscle, draws towards each other the os hyoides and larynx.

Stylo-Hyoideus.

This muscle takes its rise from the styloid process of the temporal bone: it descends obliquely downwards and forwards, and is fixed to the cornu of the os hyoides at its junction with the body of the bone. The digastric generally passes through this muscle. This muscle draws the os hyoides upwards and to one side.

Muscles of the Pharynx.

The muscles proper to the pharynx are described at the same time as the pharynx.

Muscles of the Glottis.

In a future part of this work, these muscles will be described along with the cartilages of the larynx, with which they are connected.

SECTION II.

OF THE TENDINOUS APONEUROSES, AND MUSCLES OF THE PARIETES OF THE ABDOMEN.

In the fore and lateral parts of the parietes of the abdomen, there are three distinct strata of muscles; which being subservient nearly to the same purpose, I shall describe in the order in which they present upon dissection.

Of the Superficial Fascia.

Upon removing, with care, the skin of the belly, a thin fascia, or rather membrane, presents itself, which has been said by some to take its rise only from the inferior part of the tendon of the external oblique muscle, and has been described by Camper. It rarely exhibits a fibrous appearance in the adult; and the fibres, when distinct, pass in a transverse direction with respect to the abdomen. These fibres do not resemble tendinous fibres, being neither to the eye glistening, nor communicating to the touch the same dense feeling as tendon. This membrane is proportionally thicker in the fœtus. This fascia, which has always appeared to me to consist chiefly of condensed cellular substance, covers the spermatic cord and round ligament of the uterus, and also some of the inguinal glands of the upper and under cluster; and may, in some subjects, at the upper part of the thigh, be divided into layers, between which some small lymphatic glands are placed. In a few cases, it may be readily traced for six

or eight inches down the thigh. This membrane, in some cases of scrotal hernia, attains a very considerable thickness; in others, it adheres so intimately to the hernial sac, that it is impossible to separate the one from the other.

Of the Costo-Abdominalis, or *External Oblique Muscle of the Abdomen.*

This muscle originates by eight, sometimes by nine heads, which are, in some measure, like to right angles, from the eight or nine lowest ribs, and not at a great distance from the cartilaginous parts of the ribs. The upper head adheres to the origins of the serratus anticus major, and the lower to the latissimus dorsi. All the heads adhere to the neighbouring intercostal muscles. The different heads of the oblique muscle are greater in breadth than in thickness. The fibres of the muscle proceed obliquely forwards and downwards, and terminate in a thin tendinous aponeurosis. The larger tendinous fibres of this muscle are sometimes, though rarely, separated from each other. The upper part of the muscle passes transversely across the body, and is connected by its tendon to the lower part of the larger pectoral muscle. Where the tendon of this muscle is united with that of the subjacent muscle, there is a curved white line visible, which has been called Linea Semilunaris.

The tendons of the external oblique muscles of opposite sides unite with each other, and form a distinct white line in the middle of the body, which extends from the Cartilago-Ensiformis to the pubes. The linea alba has therefore been described as the place where the one external oblique muscle is inserted into the other.

The larger fibres of the tendinous aponeurosis attached to the lower portion of the external oblique muscle, descend obliquely inwards and downwards; are disposed in a parallel manner in respect to each other; and, between these, there is a much thinner tendinous substance.

The larger tendinous fibres of the external oblique muscle, are united together by means of many thin tendinous fibres,

which take their rise from the crural arch. These smaller connecting fibres are by no means equally manifest in every instance, being, in some persons, very small and flattened; but, in others, distinct, thick, and rounded cords; and, in hernia, sometimes become very large, and make a distinct impression on the hernial sac *. Sometimes these connecting fibres are entirely wanting.

The under part of the tendon of the external oblique muscle, stretched between the anterior superior spinous process of the ilium and the symphysis pubis, is thicker and stronger than any other part of it, and somewhat rounded, especially towards the ossa pubis. It has been described under the name of Poupart's Ligament; and, more lately, it has been called by anatomists *Crural Arch*, as it extends over the flexor muscles, great bloodvessels, and nerves of the thigh. This under part of the tendon was formerly supposed to be attached only to the anterior superior spinous process of the ilium, and the ligament of the symphysis pubis.

Mr Gimbernat has however shewn, that the tendon is doubled inwards, and forms a canal for the spermatic cord in the male, and for the round ligament of the uterus in the female.

Poupart's ligament, or the crural arch, is sometimes *double. I have seen two such ligaments on each side.* When that is the case, the one ligament is generally fixed about a line above the tubercle of the pubes, and the other is found in its usual situation. About an inch, or a little more, from the symphysis pubis, the tendon of the external oblique muscle is generally divided into an upper and under column; but, in some instances, the division takes place at a greater distance from the symphysis pubis. Between the tendinous columns, which are connected at the upper part by a few transverse tendinous fibres, a space intervenes, which is somewhat of an oval figure, and has been commonly called the Spermatic Ring; but this term conveys an inaccurate idea of the form of this aperture, and it should be called Inguinal or Abdominal aper-

* Vide Plates of Inguinal Herniæ by Camper.

ture, with the addition of the word *Under*, to distinguish it from the *Upper* Inguinal or Abdominal Aperture.

Through the Under Abdominal Aperture, the spermatic cord passes; and, in the female, the round ligament of the uterus: there is no direct opening into the abdomen, the passage being shut up by the internal oblique, and transverse muscles, and by the fascia transversalis.

The under abdominal aperture in the male is somewhat curved above, angular below, and directed obliquely downwards and inwards; and the sides of it are thicker than its upper or under part, being formed of the straight fibres of the tendon; whereas, the thinner tendinous substance, which connects the thicker fibres of the tendon, forms the upper part of the aperture. In the male, the *Under Inguinal Aperture* is about an inch in length; but, in the female, it is rather longer, and also narrower.

To the upper column of the tendon of the external oblique muscle, which forms the *Under Abdominal Aperture*, a thin portion of tendon is fixed, which passes downwards, and is attached to the gluteus maximus and triceps adductor muscle of the thigh, which has also been observed by Camper, and represented by him in one of his excellent plates of hernia: this, by embracing the spermatic cord, proves, in some measure, a barrier against hernia.

The upper part of the tendon of the external oblique muscle passes obliquely downwards and inwards, and is, in part, fixed to the ligament of the symphysis pubis of the same side, and also to that part of the ligament of the opposite side, decussating, in its course, the tendinous fibres of the external oblique of the opposite side; so that some of the tendinous fibres of the right side terminate in the left os pubis.

The portion of the tendinous aponeurosis forming the under part of the *Under Abdominal Aperture*, is folded under the spermatic cord, and round ligament of the female; passes inwards, and is inserted into the spinous process of the os pubis, and linea ilio-pectinea (a term used by my grandfather in his Osteology), for the space of about an inch, or a little more. Some have described this insertion of the under

column as a distinct ligament. In the erect posture, this part of the tendon of the external oblique is placed almost horizontally, and is much deeper than the upper part of the tendon. The upper and under parts of the tendon of the external oblique muscle are widely different in another respect: The upper and outer is a thick rounded cord, extending from the spine of the os ilium to the tubercle and symphysis of the pubes: the under is reflected backwards and inwards, and is extended over the femoral bloodvessels; and its posterior edge is very thin. The crural bloodvessels, lymphatics of the inferior extremities, the internal iliac and psoas muscles, and the protruded bowels, in cases of crural hernia, pass behind the crural arch.

Ilio-Abdominalis Medius, or *Obliquus Abdominis Internus.*

This muscle arises from the spine of the ilium, by a thin tendon common to the serratus posticus inferior, and the latissimus dorsi; from the three lowest lumbar vertebræ, and from the inner side of the crural arch. From these origins the fibres describe a radiated course upwards; and, at the linea semilunaris, the tendon is fixed to the muscle, which divides into two layers; one of which joins that of the external oblique, and forms the fore-part of the sheath of the rectus muscle; the other joins that of the transverse muscle, and goes behind the rectus, forming the posterior part of the sheath, till about half way between the navel and os pubis. This muscle is fixed into the linea alba, the cartilages of the false ribs, and the cartilago ensiformis.

Lumbo-Abdominalis, or *Transversus Abdominis.*

This muscle arises from the inner side of Poupart's ligament; from the back-part of the spine of the ilium; from the inner surface of the six lower ribs; and from the transverse processes of the four uppermost vertebræ of the loins.

The fibres of this muscle run transversely across the abdo-

men, and are fixed into the linea alba and ensiform cartilage of the sternum.

Sterno-pubalis, or *Rectus Abdominis.*

This muscle arises from the cartilages of the three undermost true ribs, and extremity of the breast-bone. It forms a broad flat muscle, which is disposed in a parallel manner to the linea alba; and it is at length fixed into the fore and upper part of the os pubis. In its course to the umbilicus, three tendinous lines pass across it; and, between the navel and the ossa pubis, there is a portion of tendon which extends only half way across the muscle. Owing to the distention of the muscles during pregnancy, considerable pain is often felt at the insertion of the recti muscles into the ossa pubis.

Pubio-sub-umbilicalis, or *Pyramidalis.*

This muscle is named Pyramidal from its shape. The base of the pyramid is connected to the upper part of the symphysis pubis; and the apex of it is fixed into the linea alba, about half way between the navel and ossa pubis.

The muscles of the parietes of the abdomen, besides compressing the hollow bowels included within them, and also the bowels of the pelvis expelling their contents, tend to bend the body to a side, and draw the ribs directly downwards; or, if the thorax be fixed, the pelvis is drawn upwards: by their continued action, the heels may be thrown over the head. It may be proper to add, that the internal oblique muscle of the right side co-operates in its action with the external oblique of the left side. The tendinous sheath of the sterno-pubalis preserves that muscle in its proper place when the body is bent.

Anatomical Description of the Internal Parts in the Male.

Upon removing the peritonæum which lines the abdominal, iliaco-internus, and psoas muscles, the umbilical arteries changed into ligaments, and the urachus, come into view. The spermatic vessels are also exposed; and these sweep a-

long the brim of the pelvis, over the surface of the iliacus internus muscle; and, upon reaching the upper abdominal aperture, the vas deferens is added. The spermatic cord, thus formed, then passes obliquely downwards and forwards, along the lower part of the internal oblique and transverse muscles of the abdomen in its course, receiving from the internal oblique the cremaster muscle; and then, at the *under abdominal aperture*, it suddenly forms an angle, which covers the insertion of the outer tendinous column of the external oblique muscles into the pubes, and then passes directly into the scrotum.

This peculiar course of the spermatic cord has been very faithfully represented by Vesalius, in the wooden plates affixed to his book, and also by Albinus. It was reserved for Sir Astley Cooper, to detect and describe the *upper abdominal aperture*, which may be perceived by introducing the finger into the *under abdominal aperture*, and, by pushing it upwards in the direction of the anterior spinous process of the ilium, the borders of the *upper aparture* may then be perceived about an inch nearer to the anterior spinous process of the os ilium than the *under aperture*, the borders of which are in part formed by the internal oblique and transverse muscles, and by the fascia transversalis.

The inguinal canal of the adult follows an oblique course, and about an inch intervenes between the *upper* and *under apertures* of that canal. The upper part of this inguinal canal, called *upper abdominal internal aperture*, is formed by the transverse and internal oblique muscles, and the fascia transversalis; and the *external* or *lower abdominal aperture*, is formed by the disunion of the tendons of the external oblique muscle.

In the fœtus, the spermatic cord passes *directly* through the parietes of the abdomen.

The internal or posterior part of the crural arch is always distinct. It is marked by a white line in the tendon, which extends from the anterior spinous process of the os ilium to the linea ilio-pectinea, and feels like a tense cord when the limb is extended; but, when the thigh and leg are raised to

nearly a right angle with the body, the internal edge of the crural arch is thrown into a state of relaxation; which position is favourable, not only to the displacement of the bowels, but also to the replacing the bowels when protruded. A continued tendinous membrane lines the internal parts for the internal or posterior margin of the crural arch is intimately interwoven with the tendinous fascia which covers the iliacus internus and psoas magnus muscles, which is connected to the crista of the ilium, to the linea ilio-pectinea and ligament of the pubes; also with that fascia, or ratner membrane, which covers the transverse muscles, as far as that part of the thigh where the anterior iliac artery and vein emerge from the pelvis: Thus, the crural arch is firmly bound down, and the bowels can be protruded only through the crural aperture.

Of the Crural Sheath.

A part of the iliac fascia passes behind the crural vessels, and is firmly united to the pubal part of the fascia lata, forming the posterior part of the crural sheath; and the crural vessels are covered anteriorly by the fascia transversalis, crural arch, and cellular substance. Thus, the beginning of the crural sheath is formed, and the above fasciæ unite at the sides, and form the lateral portions of the sheath.

The anterior iliac artery and vein are closely enveloped by the same kind of cellular sheath as the other arteries and veins of the body; which sheath is firmly fixed to the inner edge of the crural arch by short cellular threads; and between the artery and vein there is a distinct division.

Of the Crural Aperture.

On the side of the anterior iliac vein, next the pubes, there is an aperture called Crural, somewhat of an oval figure, and considerably larger in the female than in the male, which is generally filled by a cribriform membrane, through which the lymphatics of the inferior extremities enter the pelvis, and sometimes, though very rarely, by a membrane, which has somewhat of a ligamentous nature, and sometimes by lympha-

tic glands, and, according to Mr Cooper, also by a portion of the fascia transversalis.

On the fore part of the *crural aperture*, the crural arch is placed behind the pubes; and on the pubal side of it, the thin border of the internal part of the crural arch, sometimes called *Gimbernat's* ligament, or the third insertion of the external muscle, by Sir Astley Cooper.

There is a considerable difference as to the size of this aperture in the male and female. It is considerably larger in the latter *, owing to the greater size of the bones of the pelvis, to the smaller size of the iliacus internus and psoas muscles, and chiefly, as I discovered, to the greater narrowness of the internal part of the crural arch, fixed into the pubal part of the inea ilio-pectinea.

Of the Fascia Transversalis.

The attention of antomists has been lately drawn to a thin fascia †, which is seen upon removing the peritonæum lining the abdominal muscles, which was discovered by Sir Astley Cooper ‡. This fascia lines the under part of the transverse muscle of the belly, is connected with the inner or posterior part of the crural arch, and then ascends for four or five inches upon the transversalis muscle of the abdomen, upon the surface of which it is gradually lost.

This fascia serves two important purposes: it shuts up the direct passage into the cavity of the belly, behind the under abdominal aperture, and by dividing into the ilial and pubal portions, forms in a great measure the upper abdominal aperture. This transversalis fascia is so dilatable, that in herniæ

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* The plates in my Treatise upon the Morbid Anatomy of the Gullet, Stomach, and Intestines, clearly point out the distinctions between the size of the crural aperture in the male and female.

† I have described this fascia transversalis, and upper abdominal aperture, as in the parts dissected, which Sir Astley Cooper was so polite as to send to me.

‡ Sir Astley Cooper has stated, that, in some instances, it is merely condensed cellular substance.

of some standing, the upper aperture is nearly opposed to the under aperture.

There are some fibres from the under column of the external oblique muscle, which strengthen the back part of the inguinal canal.

The diaphragm and levator ani should perhaps be described in this place, as they have a great effect upon the bowels of the abdomen.

But as the diaphragm cannot be seen until the viscera of the abdomen are removed, I shall describe it under the head of the muscles of respiration.

The levator ani I propose to describe under the head of muscles proper to the anus.

As the fascia lata of the thigh is intimately interwoven with the fasciæ of the muscles of the abdomen, and as the relation and connection of these fasciæ is necessary to the explanation of the nature of *herniæ*, I have subjoined a description of the fascia lata of the thigh.

Of the Fascia Lata of the Thigh.

The muscles of the thigh are covered by a strong tendinous aponeurosis, called Fascia lata, which takes its rise from the outer rounded portion of the crural arch, from the spine of the ilium, and from the pubes.

Beneath the crural arch, (supposing the body to be erect), an oval-shaped depression may be perceived on the fore, and rather on the inner part of the thigh, on the surface of the pectineus muscle, which is bounded by a well defined tendinous border, except at its inner edge.

The situation of the above-mentioned depression merits notice, as marking the situation of crural hernia. In the fascia lata, there is an aperture through which the vena saphena major passes, to join the femoral vein, the borders of which aperture are covered by fat, cellular substance, and lymphatic glands. The fascia lata has been described as being composed of two distinct portions: one of which covers the upper and outer part of the thigh, and is connected with the larger

share of the crural arch, between the anterior spinous process of the os ilium and tubercle of the pubes, and may be called *ilial* portion; and the other, which arises from the pubes, *pubal* portion. Where the iliac part of the fascia lata ceases to be united to the crural arch, it forms a fold of the shape of a sickle, the concavity of which looks downwards and inwards; which was first accurately described by Mr Burns of Glasgow, and called, by him, the falciform process of the fascia lata; and this covers that portion of the femoral artery and vein which is found immediately under the crural arch, and the under part of the iliacus internus and psoas muscles.

The other, or *pubal part*, which is thinner than the *ilial portion* of the tendon, arises from the pubes, and covers part of the pectineus and triceps muscles, and is united with the *ilial* part, beneath the vena saphena major, where that vein joins the femoral vein.

From the preceding description of the Muscles of the Abdomen, it follows,

1*st*, That as the hollow bowels of the abdomen are in immediate contact with the peritoneum lining the abdominal muscles, there must be a constant action and reaction between the containing and contained parts; and hence, that any cause which increases the pressure of the contained bowels, or diminishes the resistance of the containing parts, may give rise to hernia.

2*dly*, That as the contents of the abdomen are placed between two compressive forces, the abdominal muscles and diaphragm, which act alternately or conjunctly upon these, any violent action of the former, or of the latter, or the inordinate combined action of both, may occasion a displacement of the bowels of the belly; hence hernia is frequently occasioned by violent coughing, straining at stool, blowing wind instruments, &c. and especially by lifting heavy weights, as then the muscles exert themselves with a great force when the body is bent, and when the parietes of the abdomen are at the same time relaxed.

3*dly*, That if the peritoneum lining the abdominal muscles

be not ruptured, it forms the hernial sac, as it must be pushed forwards before the bowels which have been displaced.

4th, As the parietes of the abdomen do not give the same degree of support to their contents where the spermatic cord, round ligament of the uterus, and the crural bloodvessels, pass outwards, the bowels are protruded at such places, and the frequency of the protrusion bears a ratio to the size and direction of the aperture in the parietes of the abdomen.

From the greater size of the inguinal canal of the male, men are more frequently afflicted by inguinal herniæ; and this disease is more dangerous to women, there being, on account of the smaller diameter of the inguinal canal, a greater risk of strangulation.

5th, That the spermatic cord and round ligament of the uterus, which are imbedded within the inguinal canal, cannot be compressed during the action of the abdominal muscles, owing chiefly to the peculiar manner in which the under tendinous column of the external oblique muscle is folded beneath the spermatic cord, and fixed to the linea ilio-pectinea.

6th, That the oblique course of the spermatic cord and round ligament of the adult, proves a great barrier to the protrusion of the contents of the abdomen and pelvis, as it serves in some measure the office of a valve, but as the *upper aperture* is immediately opposite to the *under aperture* in an infant, infants are much more exposed to the hernia at the groin than adults.

7th, As the space of about an inch intervenes between the *upper* and *under abdominal apertures*, the intestines may not always pass through the *under inguinal aperture*, but may be arrested in their course downwards between the *upper and under apertures;* and in these circumstances, the tumour is not external to the parietes of the abdomen, and but of small size, the inguinal canal not admitting of much extension.

8th, That the phrase Stricture at the *Under Abdominal Aperture*, which has been employed even by the most celebrated surgeons, may convey an incorrect idea of the cause of the strangulation in cases of herniæ; for it implies, that the spasmodic contraction of the tendinous bands of the external oblique muscles occasions the strangulation.

Mr Pott remarks, "that the mere stricture made by the tendon in the generality of incarcerated rupture, is not only a sufficient, but the primary, and indeed sole, cause of the symptoms, and of all the mischief;" an opinion which may lead to the supposition, that tendons are capable of contraction on the application of a stimulus.

But tendons possess no contractile power, and if the size of the *under abdominal aperture* had been diminished by the spasmodic contraction of the external oblique muscle, this must have been felt by the patient, or by any one who examined it.

The tendon is not the active cause; the pressure is occasioned by more of the intestine or omentum being forced into the *Under Abdominal Aperture*, than can lie there without being much compressed, and the mischief does not result from the *Aperture* being less, but from its contents being greater; for when the bowels have been suddenly protruded, where there is no predisposition to hernia, the tendinous columns of the *Under Abdominal Aperture* cannot receive the bowel or bowels which are out of the abdomen, without making great and dangerous pressure upon these.

And in a rupture of some duration, even where the inguinal canal has been extended, and where an extraordinary portion of the intestines has, from any cause, been forced down, the strangulation is not occasioned by the spasmodic contraction of the tendinous columns of the external oblique muscle.

The remedies that are usually employed with the greatest success for the cure of herniæ, afford an additional argument in favour of the above opinion.

Supposing the strangulation to be owing to the contraction of the tendinous fibres of the *Under Inguinal Aperture*, or of the *Crural Aperture*, the application of cold water, vinegar, snow, or ice, instead of removing the disorder (which they certainly sometimes do) should, by bringing on a greater degree of contraction in the *Tendinous Apertures*, render the disease still more obstinate; whilst, on the other hand, warm fomentations, which induce relaxation, should always prove an antidote to the disorder, whereas they do much

more harm than good, for, by rarifying the air within the protruded intestine, they add to the bulk of the tumour, and aggravate the disease.

Where the bowels are strangulated at the *Navel*, or at the *Under Abdominal Aperture*, it seems to me to be owing to the bowels being stretched, twisted, and inflamed, and forced into a part where there is a sufficient cavity for their reception, and to their bulk being increased by an effusion of lymph upon their surface, between their coats, or within their cavity.

9*th*, That the strangulation at the *Upper Abdominal Aperture* may be occasioned either by the fascia of the transverse muscle, or by a spasmodic contraction of the internal oblique muscles. If it is occasioned by the latter, it may be removed by those remedies which occasion great relaxation, as venesection, fomentations, or the warm bath; whereas, if a tendon be the course of the strangulation, such applications produce no good effect, tendons being incapable of relaxation or contraction.

10*th*, That the tendinous columns of the external oblique muscle do not always separate from each other, so as to form the *Under Abdominal Aperture* at the same place: hence the tumour in an inguinal herniæ has not always precisely the same situation; and if the smaller tendinous fibres which unite the larger tendinous columns be awanting, though the hernial tumour be truly a protrusion through the inguinal canal, it may have the same situation as a crural hernia.

11*th*, That when the bowels are protruded through the inguinal canal, and pass along the spermatic cord, these are directed obliquely downwards and inwards, in which situation they are covered by the cremaster muscle, and the membrane derived from the tendon of the external oblique muscle, which has been called the Superficial Fascia.

12*th*, That as the inguinal apertures are extended in consequence of the bowels passing repeatedly through these, the *Upper Inguinal Aperture* may be so much enlarged, as to be brought immediately opposite to the *Under Abdominal Aperture*; and, in such a case, no part of the hernial tumour

has an oblique direction, for it passes directly through the parietes of the abdomen.

13*th*, That as there is fat around the *Under Abdominal*, and also at the *Crural Apertures*, if there be an unusual quantity of it in such a situation, it may bear a strong resemblance to a hernia; and should colic, constipation and vomiting, follow, the case may be supposed to be a strangulated hernia.

14*th*, That, on account of the connection of the crural arch with the neighbouring fasciæ, when we wish to relax as far as possible the superficial fascia, and the inguinal canal, to take off the pressure and stricture upon the displaced intestine, it is necessary to raise the head and pelvis of the patient (who is supposed to be in bed) with pillows, to bend the thighs very considerably, and to throw the knee of the affected side over to the opposite side, leaving only sufficient space for the surgeon to introduce his hand. On attempting to reduce such herniæ, the pressure should be made in the same direction as the hernial tumour, that is, in a recent inguinal hernia, the pressure should be made in the direction of the anterior spinous process of the os ilium; and in a hernia of some duration, directly upwards, as the *Upper* and *Under Parts* of the *Inguinal Canal* are, in such a case, nearly opposite to each other.

15*th*, That unless the truss shall make pressure, not only upon the *Under*, but also upon the *Upper Abdominal Aperture*, the inguinal hernia will not be removed; and that a truss which presses only upon the *Under Aperture*, instead of affording relief, exposes the patient to strangulation at the *Upper Abdominal Aperture*, or between the *Upper* and *Under Abdominal Apertures* *.

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* In justice to my Father, I cannot forbear from describing a Truss for an Inguinal Hernia, which he directed to be made many years ago, and which several of his patients have worn with much benefit.

The cushion of the common truss is so small as to cover one of the Apertures only, and, from its thinness, when the circular is tightened, with the view of increasing the pressure on the Aperture, the pad is raised forwards from the Aper-

16*th*, That, on account of the connection of the ilial and transverse fasciæ with the Crural arch, the bowels can be protruded only through the foramen crurale; and that, from the greater size of the female *Crural Aperture* the greater width of the female pelvis, a smaller size of Gimbernat's Ligament, and of the iliacus internus and psoas muscles, women are more exposed to crural herniæ than males.

17*th*, From the small size of the *Crural Aperture*, and unyielding nature of the parts around it, strangulation is more common in this kind of hernia than in the inguinal, especially in the male.

18*th*, That the bowels in crural herniæ are frequently protruded in a direction perpendicular to the abdomen, and on the fore-part of the pectineus muscle; and, on account of the small size of the *Crural Aperture*, and unyielding nature of the parts in the vicinity of it, the neck of the tumour is but of a small size, nearly of an uniform diameter, and from half an inch to three quarters of an inch long. On account of the quantity of cellular substance at the bend of the thigh, which yields readily; on account, also, of the falciform process of the fascia lata, the tumour, in a case of the crural hernia, does not descend, but is reflected, or, as I in my Observations on Crural Herniæ observed, tilted upwards upon the crural arch, so that the fundus of it is in the most prominent part, and the body and neck of the sac form a considerable angle with each other; and the tumour sometimes expands laterally to a considerable extent.

19*th*, Owing to the superficial fascia, the quantity of fat, cellular substance, and lymphatic glands, which cover a crural hernia, it is very difficult to detect that disorder, which may very readily be mistaken for a swelling of the lymphatic glands, as a crural hernia may exist at the same time as a swelling of these glands: hence the surgeon must judge of

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ture, because the Ossa Ilia and Ossa Pubis are more elevated than it, in consequence of which the truss does not produce the desired effect.

He therefore directed, that the pad of the truss should be made much thicker and larger, and placed with such a degree of obliquity, with respect to the circular, as to press upon both Apertures at the same time.

the nature of the disease, by the history of the symptoms, as much as by the knowledge he gains by examining the tumour by his fingers.

20th, As the inguinal lymphatic glands lie over the *Crural Aperture*, œdema of the limb of the affected side may be produced, by wearing a truss for the cure of the crural hernia.

21st, That the coverings of a crural hernia vary according to the situation of the tumour.

22d, From the connection of the fascia lata with the tendon of the external oblique muscle, it is obvious, that, if the thigh be extended, the crural arch must be put upon the stretch; and, on the other hand, when the thigh is rotated inwards, and raised nearly to a right angle with the body, the crural arch is relaxed; hence the pain which the extending the thigh creates in some cases of crural hernia.

23d, That in many cases of crural hernia, the stricture is so complete, that the surgeon finds great difficulty in introducing even the nail of his finger as a director, and is under the necessity of making the division of a few of the tendinous fibres (for it is surprising how little removes the stricture) in the direction in which there is sufficient room. Upon dividing the tendinous fibres, a little crack is heard, and the stricture is taken off.

24th, That as, in our erect posture, the bowels gravitate directly against the *Crural Aperture*, there is less chance of removing a crural than an inguinal hernia, by the use of a well-made truss.

25th, That the umbilical ring may be slit up in any part, without the risk of wounding any bloodvessel of importance.

26th, That in ventral herniæ, there must be a separation or rupture of some of the muscular fibres of the parietes of the abdomen.

Such is the account of the parts concerned in Hernia, and such the inferences from it, which I have for several years past delivered in my courses of Lectures. But notwithstanding all that has been lately written upon the anatomy of the parts

concerned in the inguinal and crural herniæ, there is a branch of the subject which has not yet been explained to the medical world,—I mean the gradual formation of the inguinal canal.

Having found that the late Mr Allan Burns of Glasgow, had devoted a great deal of attention to this branch of the subject, I requested of him to favour me with his observations; with which request he readily complied, and, by his permission, I have inserted these in his own words.

" When we remove carefully all the cellular membrane from over the external oblique muscle, we still find the muscular fibres covered by an aponeurotic expansion, which, toward the lower part of the belly, branches off into two processes. One plate we trace descending along the thigh, investing the glands, and forming the subcutaneous fascia; the other turns inwards, and incorporates itself with the fatty ligamentous substance found above the pubes, and adhering in males to the ligamentum suspensorium penis; and, in females, to the ligament of the clitoris. Camper, the celebrated Dutch anatomist, adds, " et involucrum dat musculo cremasteri.' Sir Astley Cooper also describes most accurately the fascia, which he represents as originating from the aponeurosis of the oblique muscle, and investing the tunica vaginalis, forming for it a sheath. This fascia is naturally not very strong, but in hernia it is sometimes immensely thickened. In one specimen of this disease in my possession, it is fully a quarter of an inch thick.

" When we divide longitudinally the sheath of the cremaster, or Camper's fascia, we bring into view the tunica vaginalis, covering the spermatic cord; and if we trace the latter up toward the abdomen, we lose it where it enters the lower orifice of the inguinal canal.

" In the fœtus, or new-born male, we find that the tendon of the external oblique muscle, at its inferior and anterior part, separates into two pillars, which leave between them an irregular opening, through which the cord passes. One of these pillars runs below the cord, the other above it. Both pillars tend obliquely downward and forward, inclining to-

ward the crest of the pubis, where one is completely lost, the other in part implanted. That fold which passes below the cord is completely implanted into the tough ligament which covers the tubercle of the pubes. The other pillar, when it reaches the pubes, separates into two bands; the posterior, or deeper-seated, is inserted along with the lower pillar into the tubercle of the pubes, and even extends to the opposite side. The other, and by far the most important fillet, winds obliquely inward, then bending backward between the penis and the cord, it at last incorporates itself with the fascia covering the heads of the triceps longus, the gracilis, and flexor muscles of the leg, and in some cases it can be traced much farther, and reaches even to the tendon of the glutæus maximus, to which it is attached. This slip from the upper pillar of the canal, is always inseparably joined to the fasciæ covering the cremaster; indeed, it may perhaps most properly be described as a part of CAMPER's fascia, attached to the ring. I thought that this structure had not been noticed by any author. I find, however, that it has not escaped that indefatigable anatomist CAMPER, who delineates it very accurately in his plate. It is easiest detected by slitting up CAMPER's fascia, by which I mean the sheath of the Cremaster, till we come near to the ring. When we have done this, if we then insinuate the point of the finger into the lower orifice of the canal in the adult, or ring in the child, we find that we are by this fillet prevented from carrying the finger toward the pubes.

" This part of the canal merits peculiar attention; for whoever is ignorant of the position and connection of this production from the upper pillar of the ring, can possess only a very confused notion of its action in disease.

" When I shall have stated the anatomy of the groin in the young subject, and have pointed out the changes which take place on these as life advances, I shall then have occasion to notice the effect of this fillet in preventing the formation of hernia; and also, we shall see that when a protrusion has actually taken place, it has a considerable share in preventing reduction.

" When we have examined in the very young subject, the structure of the external orifice through which the cord passes, we have seen all that is most worthy of notice; for, in the very early part of life, the inguinal canal is not formed. In proof of which, take a new-born male, in whom the tunica vaginalis communicates with the cavity of the abdomen, and make a puncture into the former, through which one of the blades of a pair of scissars is to be introduced, and passed into the belly; then all that portion of the tunica vaginalis, which is above the puncture, is to be snipped through. By doing this, we lay the abdomen and tunica vaginalis into one; and we at first glance perceive whether the cord, at this early period of life, passes in an oblique direction between the muscles and transversalis fascia.

" I have never observed the cord in any obvious degree *oblique* in its course; in an infant at birth, it runs *in a straight line* from the psoas muscle to the bottom of the scrotum.

" It passes through *a mere aperture.*

" When, however, we take a subject even a month old, and treat it in the same way, we find then a *very apparent obliquity* in the course of the cord. As, however, it is very rare to meet with an infant of that age, in whom the tunica vaginalis remains pervious, we may, where its canal is obliterated, by slitting up CAMPER's Fascia, and entering the blade of a sharp-pointed pair of scissars into the lower outlet of the canal, pass it up till it appears in contact with that part of the peritoneum which invests the cord at that spot where it passes from the abdomen. If we divide completely what is between the blades, we expose fairly the *degree of obliquity of the Cord.*

" If we examine, in a similar way, subjects of different ages, we find that the older they become, till they arrive near the age of puberty, *so much the longer does the inguinal canal become.*

" It may here be worth while to inquire, how the canal comes to be formed, and what changes take place on the neighbouring parts. As I have already mentioned, the upper and lower openings of the fœtal ring are *opposite to each other*, and

so very little distant the one from the other, that there is hardly a palpable space between them. The ring is placed just in contact with the tubercle of the pubis. From this fact, it must at first sight appear, that the lower outlet is in the fœtus, in the same spot which it is afterwards to occupy in the adult. In proportion, therefore, as the fœtal ring is changed into the adult canal, it is the *internal orifice* which changes its position; it is the upper opening which mounts toward the spine of the ilium. We may from this very readily understand, that it is *from the gradual extension of the transversalis fascia*, in that direction, that the cord comes to be inclosed in a canal. A very simple contrivance gives a very clear idea of the manner in which the inguinal canal is formed. Let any one take two slips of paper of the same length, and cut two small holes in the centre of each; let him then lay these holes opposite to each other, and pass through them a quill or pencil-case. When he has done this, he has a very good plan of the state of parts about the groin in the fœtus. If he now hold the papers opposite him, and then pull to a side the one nearest to himself, he will find, that, by doing this, he comes to lay the quill between the pieces of paper in the same way that the spermatic cord, by the extension upward and outward of the internal orifice of the ring, comes to be lodged in a long canal. And he will also see, that the length of the canal must vary according *to the greater or less extension of its posterior side.* Many have also been puzzled to comprehend, how the epigastric artery can bear precisely the same relation to the cord in the fœtus and adult, seeing the difference which has taken place in the relative position of the internal orifice of the canal. This difficulty only occurs to those who do not properly understand the mechanism of parts. One who has made himself acquainted with the real structure, is never difficulted in following the changes. If the state of parts in the very young subject be known, and if the surgeon have examined those at an advanced period of life, by comparing the one with the other he has at once unfolded to him the mode in which the fœtal ring is changed into the adult canal. He is taught that it is a natural consequence *of the oblique extension of the*

transversalis fascia toward the spine of the ilium. He sees, that, in proportion to the degree in which the posterior side of the canal overlaps the anterior, so must the length of the canal vary. If he take a just and comprehensive view of these parts, he will be able to see in the structure, a wise provision of Nature to prevent protrusion at the groin, and he will also be led to deduce some pathological inferences from the data before him. He will be prepared to understand why Inguinal Hernia is much more frequent in young than in old subjects; why it is often cured in the former, and seldom in the latter; and why in the one it is a more dangerous affection than in the other.

" In the very early period of life, the cord, as we have just seen, passes through a *mere aperture;* and besides, there is an open communication between the tunica vaginalis and the belly. From these circumstances, therefore, a portion of gut is forced down along the cord, forming congenital hernia; or, if the tunica vaginalis be obliterated, a new peritonæal sac passes through the ring by the side of the cord. As, however, the parts are more dilatable in the young than in the old person, so is hernia, *cæteris paribus*, more readily reducible in the former, and, consequently, less dangerous. The gut, in the first instance, in the young subject, passes through a *simple ring*, but if the hernia be allowed to remain, then in many cases the upper orifice, ascending toward the spine of the ilium, as it ought to do, comes in the end to lodge both the hernial sac and the spermatic cord, in a complete canal; and this will probably be found to be the reason why surgeons believe that hernia does often take place along the canal. They see a herniary tumour in advanced age lying in the oblique course of the canal; but they forget to inquire when the protrusion took place, and what was the original appearance of the tumour.

" Were they to trace their cases to their origin, they would most probably ascertain, that, in the first instance, the hernia had appeared in infancy, that it had been *less oblique at the beginning, but imperceptibly become more and more so.* I speak from what I have seen in several instances. Among a

considerable number of patients in whom the hernia was lodged in the canal, and of some of which I have casts, I have uniformly, by applying to the friends, ascertained that the rupture had taken place in infancy, and had slowly assumed the oblique direction. Some of the nurses have even said, that, when immediately after birth, they attempted to return the gut, they found that it had passed through a hole, about large enough to admit the tip of their little finger; but when the child was older, they found it run more to a side.

"In the advanced stage of hernia, the parts are brought into precisely the same state they were in when the disease began. In the congenital hernia, or in the common inguinal hernia taking place in a very young child, the sac passes through *a mere aperture*, then, in time we have seen, that, owing to changes which this opening undergoes, the gut comes to be lodged in a *fully formed Canal.* This continues till the tumour becomes large, when the posterior side of the canal is, owing to the pressure, slowly absorbed; and again the upper and lower orifices are brought opposite to each other. Again, the hernia resembles, in its appearance and course, the incipient tumour.

"If the view which I have given of the mode of formation of the inguinal canal be correct, it will lead to this conclusion, that we ought, in every case of Hernia in a young child, most sedulously to prevent the descent of the gut; and, if possible, to return also the sac, where it is not congenital rupture; for if we do this, we bid fair to cure the disease, by allowing of the *extension of the posterior side of the canal along the cord.* This observation leads me to a review of the influence which the different parts of the inguinal canal have in preventing the accession of hernia.

"In the very young child, there is no security against hernia, except what arises from the cord filling the aperture through which it passes. This is generally sufficient; for the infant is exposed to few of the exciting causes of the disease.

"When, however, the child advances in years, in the course

of its amusements, and afterwards of its business, it is more and more exposed to the causes of hernia.

" Nature has, however, wisely provided, that, in proportion to the danger, the security should be increased. The posterior side of the canal overlaps every day more and more the anterior side; consequently, when the canal is completed, any pressure against the posterior side, tending to produce hernia, has *the effect of laying that side more firmly in contact with the cord;* of forcing the latter steadily against the anterior side, where the fibres of the transversalis and internal oblique muscles react upon it. Thus a most perfect valve is formed, and where the posterior side of the canal is fully extended, it is impossible that inguinal hernia can take place.

" I have already attempted to show, that where the gut has passed down in infancy, it may in the end come to be lodged in a canal; but this is very different from a hernia passing along the canal for the first time in an adult. By the overlapping of one side of the canal over the other, hernia is prevented from primarily taking place in the adult, by the internal orifice of the inguinal canal.

" Although, for the reasons above stated, hernia cannot often, if ever, take place by the upper orifice of the inguinal canal; still were there not some contrivance devised, it might happen, by bursting the posterior side of the canal, opposite the lower orifice.

" The posterior side of the inguinal canal is formed, as was first demonstrated by Sir A. Cooper, by the transversalis fascia, which is thin and dilatable, and, therefore, independent of assistance, affords but a trifling barrier to protrusion. Nature has not, however, neglected this point; for, opposite to the inferior opening, she has strengthened the posterior side, by *a set of inflected fibres*, which arise, as described by Camper, from the folded-in lower pillar of the oblique muscle, and run upward, expanding over that portion of the transversalis fascia, opposite to the lower outlet. This affords one security; but Nature seems peculiarly solicitous about defending this opening, and has therefore bound the two pillars firmly together, by cross slips, and made to arise from the upper

one, a fasciculus of fascia, which, by winding round the top of the thigh, must, in those motions which would endanger the parts, be made closely to embrace the cord, adapting thus, in a most accurate manner, the size of the lower outlet to the size of the cord.

" We thus see, that, *by the posterior wall of the canal, inguinal hernia is, in the adult, prevented from taking place through the upper orifice*; and that, by the peculiarity of the mechanism of the lower opening, *ventro-inguinal hernia* cannot occur, except where, by violence, the posterior side of the canal is burst, or the cross slips torn, by which the fillet, from the upper pillar, would come to lose its effect.

" When hernia has taken place, the very objects which formerly had a tendency to prevent its accession, are now so far changed in their action, that they present obstacles to the replacement of the gut. If the hernia has occurred in a young subject, where the canal is not formed, or in an adult, in whom the posterior side is wanting, which is not a very rare malformation, then our only difficulty must depend on the action of the lower outlet. In this case, the cross fibres which bind the two pillars together, act on the sac; and the fillet, from the upper pillar, embraces it closely, but not equally, in every direction of the limb. When the toes are rolled inward, and the thigh, on the affected side, pulled from the other, and turned backward, this fillet is sunk into the sac, and retains it immoveably in its situation.

" This species of stricture may most readily be overcome, by moving the member in an opposite way; and, I believe, in knowing how to humour the parts in the taxis, the great superiority of one surgeon over another consists. When, however, the rupture has taken place in infancy, and continued till the complete extension of the canal is accomplished, then, besides this source of difficulty, there is also a source of embarrassment, arising from the reaction of the fibres of the transversalis and internal oblique muscles upon the sac, which occasions a species of stricture, in which bloodletting, warmth, and the relaxing the muscles by bending the body sideways, facilitate the reduction. The above remark applies to that

species of incarceration dependent on a narrowing of the internal orifice of the canal."

A part of the muscles of the abdomen is sometimes awanting at the navel, of which I have seen several instances in children. It also sometimes happens, that there is a defect of the smaller tendinous columns which form the inguinal canal, so that when the bowels are protruded at the under abdominal aperture, the hernia is situated at the common place of a crural hernia.

SECTION III.

MUSCLES SITUATED UPON THE BACK-PART OF THE TRUNK OF THE BODY.

These muscles have been arranged by some authors into classes, according to their situation, and by others, according to their several uses.

Albinus has divided the muscles of *the back* into four layers.

1st Layer.

There are two muscles which cover the whole of the back, the Dorso-acromialis, or *trapezius*, and the Lumbo-humeralis, or *latissimus dorsi*.

2d Layer.

NEW NAMES. *Descriptive of the situation of the Muscles.*	OLD NAMES.
Dorso-Scapularis,	The rhomboideus major.
Dorso-Costalis,	The serratus posticus superior.
Lumbo-Costalis,	The serratus posticus inferior.
	The under part of the serratus magnus.
Tendons of the Sacro-Costalis,	The tendons of the sacro-lumbalis.
A Portion of the Sacro-Spinalis or	Of the longissimus dorsi.

NEW NAMES.	OLD NAMES.
Descriptive of the situation of the Muscles.	
TRANSVERSO-SPINALIS DORSI, or	A part of the semi-spinalis dorsi. The spinalis dorsi. The broad tendon, common to the latissimus dorsi and serratus posticus inferior.
The back-part of the ILIO-ABDOMINALIS, or	Of the obliquus internus abdominis. The intercostales externi. The coccygeus. The levator ani. The sphincter ani.
Third Layer.	
	The spinalis dorsi.
Part of the TRANSVERSO-SPINALIS DORSI, or	Part of the semi-spinalis dorsi.
SACRO-SPINALIS, or	The longissimus dorsi.
TENDONS of the SACRO-COSTALIS, or	Of the sacro-lumbalis.
	The common fleshy head of the longissimus dorsi and sacro-lumbalis.
	Tendon covering and partly giving origin to the fleshy head.
	Part of this tendon upon the longissimus dorsi.
The LUMBO-ABDOMINALIS, or	The transversalis abdominis. The intercostales externi. Portions of the intercostales externi, called by ALBINUS, *levatores costarum.*
Fourth Layer.	
The TRANSVERSO-SPINALIS DORSI, or	The semi-spinalis dorsi. The multifidus spinæ. The intercostales interni. The intertransversales lumborum, interspinales lumborum.

The above named muscles, according to their uses, may be divided into the following classes:

1st, *Into the muscles proper to the spine.*
2d, *Into muscles which move the ribs.*
3d, *Into muscles which move the head.*
4th, *Into muscles of the shoulder.*

Lastly, There is a muscle implanted in the back, the *latissimus dorsi*, which is a muscle of the arm.

MUSCLES OF THE SPINE.

Sacro-Spinalis or *Longissimus Dorsi.*

This long conical-shaped thick mass of flesh, which is covered by a strong tendinous aponeurosis, from which the muscular fibres take their rise, and pass obliquely upwards, fills up the hollow between the spine and angles of the ribs.

It is connected in common with the sacro-costalis, by a strong tendon, with the os sacrum, and spinous processes of the lumbar vertebræ, and is fixed by distinct tendons into the lower edges of all the ribs, except the two lower, and into the transverse processes of the dorsal vertebræ, by small double tendons. The multifidus spinæ, complexus and transversalis colli lie on its inner, and the following muscle on its outer edge.

Sacro-Costalis, or *Sacro-Lumbalis.*

This muscle may be said to form a part of the preceding muscle: it takes it origin, in common with it, from the side of the spinous processes of the os sacrum, and from the spinous and transverse processes of the lumbar vertebræ. This muscle is fixed by flat, long, and thin tendons into the angles of all the ribs.

This and the preceding muscle keep the trunk of the body erect; and, when the trunk of the body has been bent, they bring it back to a state of extension.

From the eight lower ribs, an equal number of fleshy fasciculi take their rise, which terminate on the inner side of this muscle, and form the muscle.

This muscle assists the former in maintaining the trunk of the body erect. When the spine has been slightly distorted, the scapulæ are not on the same level. The longissimus dorsi

and sacro-lumbalis on the same side as the lower shoulder, are large and prominent, but those on the opposite side are less distinct than usual; and, instead of being convex, are rather somewhat depressed. The muscles of the back are very indistinct in women who have worn stays for some time.

Transversalis Colli.

This muscle lies on the inner side of the longissimus dorsi: it arises from the transverse processes of the six uppermost dorsal vertebræ, and is fixed into all the transverse processes of the vertebræ of the neck, except the first and last: it pulls the neck backwards and sidewise.

Cervicalis descendens.

This muscle forms a part of the sacro-spinalis, and is fixed to the transverse processes of the 4th, 5th, and 6th cervical vertebræ, by three distinct tendons.

It assists in turning the neck obliquely backward.

Spinalis Dorsi.

This muscle is placed between the spine and longissimus dorsi, from which it cannot be divided without cutting some of the muscular fibres. It arises from the spinous processes of the two upper lumbar, and three lower dorsal vertebræ, and is fixed by tendons into the spinous processes of the 2d, 3d, 4th, 6th, 7th, 8th and 9th dorsal vertebræ.

This muscle is also an extensor, and serves to fix the vertebræ to each other.

Transverso-Spinalis Colli or *Semi-Spinalis Colli.*

This muscle, which arises from the transverse processes of the seven superior dorsal vertebræ, and is connected to the spinous processes of the 2d, 3d, 4th and 5th cervical vertebræ, extends the neck backwards, and pulls it to a side.

Transverso-Spinalis Dorsi, or *Semi-Spinalis Dorsi.*

This muscle is placed nearer to the spine than the lower part of the preceding muscle.

This muscle arises from the transverse processes of the 8th, 9th, and 10th dorsal vertebræ, and is fixed into the spinous processes of the two last cervical, and five first dorsal vertebræ, by tendons: it serves to pull the spine obliquely backwards.

Besides the above muscles, there are two rows of muscular fibres between the spinous processes, and also between the transverse processes, called *Inter-Spinales* and *Inter-Transversales*, and there are also muscular and tendinous fibres which arise from the spinous processes of the os sacrum, from the oblique and transverse processes of the lumbar and dorsal vertebræ; and from the four lowest cervical vertebræ. These fibres are fixed by distinct tendons into the spinous processes of all the vertebræ, with the exception of the first, and constitute the *multifidus spinæ* of some authors.

These muscular fibres draw the spine directly backwards.

SECTION IV.

OF THE MUSCLES WHICH MOVE THE HEAD.

Movements of the Head.

The head is articulated with the atlas, or first vertebra of the neck, by a *ginglymus joint*, on which it is moved backwards and forwards, and it is nearly equipoised on the atlas. It is rather heavier before, and hence inclines forwards when a person falls asleep.

The foramen magnum ossis occipitis, is parallel to the palate; hence, in our erect posture, the eyes and mouth are directed forwards.

The head, with the second vertebra of the neck, rotates in a horizontal direction on the tooth-like process of the second vertebra of the neck; and the breadth of the articulating furface, and looseness of the synovial membrane, admit of considerable rotatory motion from right to left.

The motions of the head are very limited; this is compensated to a certain degree by the cervical vertebræ, which move along with the head.

The greater number of the muscles by which the head is moved, is placed between the vertebræ and occiput, by which the tendency of the head to fall forwards is counteracted. Hence the extensor muscles are in a state of constant action during life; and when these muscles cease from action, as during sleep, the head falls forwards.

The fibres of the greater number of these muscles are oblique, and they differ as to their obliquity. In consequence of the decussation of their fibres, the vertebræ are more firmly united, and the head is moved with greater rapidity and steadiness, and in a greater number of diagonal lines.

By the three following muscles, the head is drawn backwards, or to a side, when the muscle of one side only is thrown into action.

Cervico-Mastoideus, or *Splenius Capitis.*

This muscle is covered by the trapezius; it is flat, and somewhat like a surgeon's splent in form. It arises from the spinous processes of the four uppermost dorsal vertebræ, and five lowest cervical vertebræ; and proceeding upwards, is fixed into the occipital ridge and mastoid process of the temporal bone, and also into the transverse processes of the five uppermost cervical vertebræ.

Trachelo-Occipitalis, Biventer Cervicis of ALBINUS, or *Complexus Major.*

This muscle is covered in part by the splenius; the rest of it is seen between the splenius and the spine: it arises, by tendons, from the transverse processes of the four lower cervical vertebræ, and seven uppermost dorsal vertebræ. It forms a thick fleshy mass, in the middle of which there is a tendon, and at last terminates in the lower occipital ridge.

Trachelo-Mastoideus, or *Complexus Minor.*

This muscle arises from the five lowest vertebræ of the neck, and transverse processes of the three uppermost vertebræ of the back, and is fixed into the mastoid process of the

temporal bone. The occipital bone is moved on the atlas by the following muscles.

Axoido-Atloideus, or *Obliquus Capitis Inferior.*

This muscle, which arises from the spinous process of the second cervical vertebra, and is fixed into the transverse process of the atlas, assists in rolling the head.

Atloido-sub-Mastoideus, or *Obliquus Capitis Superior.*

This muscle is placed laterally between the atlas and occiput. It arises from the transverse process of the atlas; and passes upwards and inwards, to be fixed into the end of the lower part of the occipital ridge, and back part of the mastoid process of the temporal bone.

This muscle assists in rolling the head to one side, and in pulling it backwards.

By the two following muscles, the head is drawn backwards.

Rectus Capitis Posticus Major, or *Axoido-Occipitalis.*

The origins of this muscle are, the spinous and transverse processes of the second vertebra of the neck; the muscle becomes thicker in its ascent, and it is fixed into the os occipitis, near to the rectus capitis lateralis.

Atloido-Occipitalis, or *Rectus Capitis posticus minor.*

This muscle arises from the middle of the protuberance which is found instead of the spinous process of the first vertebra of the neck, and is fixed into the lower occipital ridge.

The two following muscles are the antagonists of the former:

Trachelo-sub-occipitalis major or *Rectus Capitis anticus major.*

This muscle arises from the transverse process of the second, third, fourth, fifth, and sixth cervical vertebra, and is fixed

into the cuneiform process of the occipital bone, where it joins with the sphenoid bone.

Trachelo-sub-occipitalis minor, or *Rectus Capitis anticus minor.*

This muscle lies under the former: it arises from the anterior part of the atlas, and is fixed into the occipital bone, near the condyle.

Atloido sub-occipitalis, or *Rectus Capitis lateralis.*

This muscle takes its origin from the anterior part of the transverse process of the atlas, and is fixed into the side of the cuneiform process of the occipital bone.

This muscle pulls the head to one side.

Some of the muscles which are fixed to the bones of the head and os hyoides, assist in the movements of the head, viz. the sterno-mastoid, sterno-thyroid, sterno-hyoid, omo-hyoid, mylo-hyoid, genio-hyoid, digastric, and platysma myoides.

The rotatory motion of the head is performed by the following muscles: axoido-atloideus, part of the splenius of the right side, the left complexus, the right platysma, and left sterno-mastoid, and right trapezius.

Prædorso-atloideus, or *Longus Colli.*

This muscle, which is situated behind the gullet and great bloodvessels and nerves of the arm, is attached to the three uppermost dorsal vertebræ, and to the transverse processes of the four undermost cervical vertebræ; and it is fixed to the fore parts of the cervical vertebræ, by tendons.

It tends, with its fellow, to bend the neck forwards; and when only one of the muscles acts, the head is pulled to one side.

Besides the above muscles, which more properly belong to the head, there are certain muscles of the shoulder, viz. the

trapezius, *sterno-cleido-mastoideus*, and the muscles arising from the sternum, which are fixed into the larynx, os hyoides, and under-jaw, which act upon the head.

SECTION V.

MUSCLES ON THE FORE PART OF THE TRUNK OF THE BODY.

THE *greater pectoral muscles* and *serrati*, placed on the front and sides of the chest, are muscles of the superior extremity. The *lesser pectoral muscle*, is a muscle of the superior extremity, or it is employed in a deep inspiration, when the scapulæ are fixed. All these muscles will be described under the head of Superior Extremities.

SECTION VI.

OF THE MUSCLES BY WHICH THE RESPIRATION IS PERFORMED.

THE muscles by which inspiration and expiration are performed, are described, together with the lungs, in a subsequent part of this work.

SECTION VII.

OF THE MUSCLES OF THE PERINÆUM AND ANUS.

THESE muscles are described in the same section as the organs of generation.

SECTION VIII.

OF THE TENDINOUS APONEUROSIS OF THE SUPERIOR EXTREMITY, AND MUSCLES PROPER TO IT.

THE muscles of the superior extremity are covered and fixed down by a tendinous aponeurosis, which extends from the different processes of the bones, and is by some authors said to take its origin from these.

The tendinous aponeurosis is thicker on the outer than on the inner side of the arm: it is thicker on the fore-arm than on the humerus, and at the wrist, the fibres of it are thicker, and are said to form the annular ligaments.

The superficial veins of the arm are disposed between the skin and the tendinous aponeurosis: also the branches of the superficial nerves, and many lymphatic vessels.

There is a strong fascia in the fore-arm, as in the leg.

The fascia is attached to the condyles of the humerus, and to the olecranon ulnæ: it is stronger on the back than on the fore part of the arm, in consequence of the addition of tendinous fibres from the triceps extensor muscle: and the tendinous aponeurosis of the fore part of the arm is rendered stronger by the addition of tendons from the *scapulo-radialis muscle.*

This fascia sends processes between the muscles of the fore arm, which have been named by some authors *intermuscular ligaments*, from which many tendinous muscular fibres take their origin.

At the wrist there are two annular ligaments; the *ligamentum carpi annulare posterius*, under which the tendons of the extensor muscles pass, which extends transversely between the styloid process of the ulna, and os pisiforme, and is fixed to the styloid process of the ulna; and the *ligamentum carpi anterius*, which passes across the fore part of the wrist, extends between the os pisiforme and os unciforme, and the os scaphoides, and under this the tendons of the flexor muscles pass to the hand.

In the palm of the hand, there is a strong fascia, which is connected with the tendon of the palmaris longus, and which covers the greater share of the palm of the hand, and is fixed to the roots of the fingers by an equal number of double slips of tendon.

There are two muscles proper to the tendinous aponeurosis of the superior extremity, the *Epitrochlo-Palmaris*, or *Palmaris Longus*, and the *Palmaro-Cutaneus*, or *Palmaris Brevis.*

Epitrochlo-Palmaris, or *Palmaris Longus.*

This muscle, which takes its origin from the internal condyle of the os humeri, and is fixed into the ligamentum carpi annulare, by means of its tendon, stretches the tendinous aponeurosis, and assists in bending the hand. It is placed between the flexor carpi radialis and flexor carpi ulnaris.

Palmaro-Cutaneus, or *Palmaris Brevis.*

This small muscle, which crosses the aponeurosis of the palm of the hand, extends between the ligamentum carpi annulare anterius and the aponeurosis palmaris, and is fixed into the skin which covers the abductor minimi digiti and os pisiforme, assists in contracting the palm of the hand.

SECTION IX.

OF THE MUSCLES OF THE SHOULDER.

Costo-Scapularis, or *Serratus Anticus Major.*

This muscle is connected to the nine superior ribs, and is inserted into the whole length of the base of the scapula.

The under part of this muscle pulls the shoulder downwards and forwards, and the upper antagonizes the under.

Trachelo-Scapularis, or *Levator Scapulæ.*

This muscle is in part covered by the trapezius and sternomastoid muscles.

The splenius capitis covers the origin of this muscle, from the transverse process of the five superior cervical vertebræ. This muscle is inserted into the superior angle of the scapula.

By this muscle the scapula is raised, and pulled forwards.

Costo-Coracoideus-Scapularis, or *Pectoralis Minor.*

This muscle takes its origin from the third, fourth, and fifth ribs, passes obliquely outwards, and is fixed into the coracoid process of the scapula; it pulls the scapula down-

wards, and also forwards; or it may raise the ribs during a laborious inspiration.

Dorso-sub-Acromialis, or *Trapezius.*

This muscle, which lies immediately under the skin, and covers all the muscles of the posterior part of the neck, and upper part of the back, adheres to its fellow for the whole length of its origin.

The ligamentum nuchæ, which is of great strength in the larger quadrupeds, arises from the middle of the occipital bone, and adheres to the spinous processes of the cervical vertebræ. Some of the fibres of this muscle take their rise from this strong ligament, and also from the middle of the occipital arch, from the corresponding muscle, over the spinous processes of the cervical vertebræ, from the spinous processes of the two inferior cervical, and all those of the dorsal vertebræ; and are inserted into the whole of the spine of the scapula, the acromion scapulæ, and the scapulary part of the clavicle.

The different portions of this muscle are subservient to different purposes: the superior part raises the shoulder; the lower part pulls it downwards; the middle portion draws the shoulders towards each other; and when the scapulæ are fixed, this muscle assists in moving the head backwards.

Dorso-Scapularis, or *Rhomboideus.*

This muscle, which lies beneath the trapezius and latissimus dorsi, arises from the spinous processes of the fifth, sixth, and seventh cervical vertebræ, and the four uppermost dorsal vertebræ is fixed into the whole length of the base of the scapula, and tends to draw the scapula backwards and upwards.

Costo-Clavius, or *Subclavius.*

This muscle fills up the space between the clavicle and first rib; it arises from the cartilage of the first rib, and is fixed into the under surface of the clavicle, as far as the coracoid process of the scapula.

It pulls the clavicle down.

Scapulo-Hyoideus, or *Omo-hyoideus.*

This muscle arises from the superior costa of the scapula, and passes obliquely upwards and forwards under the sterno-mastoideus, under which it becomes tendinous, and is fixed into the base of the os hyoides, at the side of the sterno-hyoideus.

By this muscle the os hyoides is pulled down to one side; and when both muscles act, the os hyoides is drawn directly downwards.

SECTION X.

MUSCLES OF THE ARM.

The muscles of the arm arise from the trunk of the body, or from the processes of the scapula.

Sterno-humeralis, or *Pectoralis Major.*

This muscle covers the front of the breast, and is the first muscle which comes into view, after having removed the skin, fat and, cellular substance, and the origins of the platysma myoides. It takes its rise from the sternal portion of the clavicle, and the cartilages of the 5th and 6th ribs, and is fixed by a flat twisted tendon, into the ridge which bounds the outer edge of the groove for the tendons of the long head of the scapulo-radialis muscle. This muscle is separated from the deltoid muscle by a good deal of cellular substance and fat, and generally by the cephalic vein. By this muscle, the humerus is brought forward, and the arm thrown across the breast, when it hangs by the side; but, if the arm has been raised, this muscle draws it downwards, and at the same time forwards.

Lumbo-Humeralis, or *Latissimus Dorsi.*

This thin and broad muscle, which covers the greater share of the back-part of the trunk of the body, takes its rise from the os sacrum, crest of the os ilium, and spinous pro-

cesses of the lumbar and seven inferior dorsal vertebræ, and from the extremities of the four lowest ribs. The fleshy fibres ascend obliquely, pass over the inferior angle of the scapula, are collected, twisted in the axilla, and then fixed into the inner edge of the groove which receives the long tendon of the scapulo-radialis. This muscle pulls the humerus backwards and downwards, and also rolls it.

The five following muscles arise from the scapula: the three first roll the os humeri outwards, and the other two antagonize these. The two following muscles are covered by an aponeurosis, extending between the costæ and spine of the scapula.

Super-Scapulo-Trochitereus Parvus, or *Supra-Spinatus.*

This muscle arises from that part of the scapula which is above the spine of the scapula, and from the spine and superior costa of the scapula, and its tendons pass under the acromion above the articulation, and are fixed into the anterior part of the great tuberosity of the humerus. This muscle also assists in raising the arm.

Super-Scapulo-Trochitereus Magnus, or *Infra-Spinatus.*

This muscle fills up the greater part of the scapula, which is below the spine of that bone; the fibres of it are oblique in respect to its tendon, which is fixed into the middle part of the greater tuberosity of the os humeri. The trapezius muscle covers the upper and back part of this muscle, and the anterior part of it is concealed by the deltoid muscle. This muscle assists in raising the arm, and rolls it outwards when raised.

Super-Scapulo-Trochitereus Minimus, or *Teres Minor.*

This muscle arises from the inferior edge of the scapula, between the infra-spinatus and teres major; it ascends along the under edge of the infra-spinatus, and is fixed into the back-part of the larger tuberosity of the os humeri. As the tendon of this muscle is fixed to the capsular ligament, and

obliquely to the tubercle of the humerus, it gives the humerus a degree of flexion.

Scapulo-Humeralis, or *Teres Major*.

This muscle arises from the dorsal side of the inferior angle of the scapula, and is fixed into the ridge, at the inner side of the groove for lodging the long head of the scapulo-radialis, along with the tendon of the latissimus dorsi. The use of this muscle is to roll the os humeri inwards, in which it is assisted by the latissimus dorsi; and, when we act with the latissimus dorsi and teres, the palm of the hand is turned backwards, ready to grasp any body behind us.

Sub-Scapulo-Trochineus, or *Sub-Scapularis*.

This muscle is concealed by the scapula, and fills up the space under it; from the three costæ of that bone, it takes its origin. The radiated fibres of this muscle make prints upon the bone. It is fixed into the smaller tuberosity of the os humeri, which it rolls inwards.

Sub-Acromio-Humeralis, or *Deltoideus*.

This thick and strong mass of flesh, which lies under the skin, and forms the upper and outer portion of the shoulder, covering the ball of the os humeri, is broad above, and narrow below, and in form bears some resemblance to the *Greek* Δ. It consists of various fasciculi. This muscle arises from the sternal half of the clavicle, from the acromion, and part of the spine of the scapula; it gradually becomes narrower, and is fixed, by a strong tendon, into a rough surface on the outer side of the os humeri near to its middle. This muscle covers the insertion of the greater pectoral muscle, and the origins of the biceps flexor cubiti and coraco-brachialis. This muscle has, by some authors, been divided into three distinct parts, and has been represented as three different muscles by LEONARDO DA VINCI in his anatomical drawings *.

* These drawings are in his Majesty's collection, and engravings from them have been published by Mr CHAMBERLAINE.

The anterior portion proceeds obliquely backwards; the middle, which covers the ball of the os humeri, is in its descent nearly straight, and the posterior portion of the muscle passes obliquely forwards. When the arm is hanging by the side, it is raised by the deltoid to a right angle with the body, and it is thrown forwards or backwards, according as the anterior or posterior portions of the muscle are brought into action: when the arm has been raised, if the anterior part acts, the arm is thrown forwards; and, if the posterior portion be brought into action, the arm is drawn downwards and backwards.

Coraco-Humeralis, or *Coraco-Brachialis.*

This muscle arises, in common with the short head of the biceps muscle, from the fore-part of the coracoid process of the scapula; it is placed behind the biceps muscle, and is concealed by the greater pectoral and deltoid muscles, and is fixed into the middle of the humerus, below the insertion of the latissimus dorsi and teres major muscles. It is used to raise the arm obliquely forwards.

SECTION XI.

MUSCLES OF THE FORE-ARM.

There are two flexors, and only one extensor of the fore-arm.

Of the Flexor Muscles.

Scapulo-Radialis, or *Biceps Flexor Cubiti.*

This muscle has two origins, one in common with the coraco-brachialis, from the coracoid process of the scapula, and the other, the longer, from the upper part of the glenoid cavity: the longer head passes over the ball of the os humeri within the joint: it is retained by a ligament within a groove in the upper-part of the os humeri, and is fixed by a strong round tendon, which is placed between the supinator

radii longus and pronator teres, into a small tubercle on the upper and inner side of the radius, and into the aponeurosis of the fore-arm. By this muscle the fore-arm is bent, the hand is turned supine, the fascia is tightened, and the arm is raised towards the shoulder.

I saw, some months ago, an instance in which the elbow had been dislocated for some years: the radius projected considerably upwards and forwards, the ulna was destroyed, and had been cast out; notwithstanding which, the man could bend the fore-arm a little, and also perform the pronation and supination of the hand.

Humero-Ulnaris, or *Brachialis Internus.*

This oblong, thick, and broad muscle takes its rise from the lower third of the anterior part of the os humeri; it is fixed, by many fleshy fibres, to the surface of the os humeri, and it gradually diminishes in breadth as it passes over the joint, adhering firmly to the capsular ligament, and is fixed into the coronoid process of the ulna.

Of the Extensor Muscles.

Olecrano-Scapularis or *Triceps Extensor Cubiti.*

This muscle covers the back of the arm; it arises by three heads. The first or longest share of this muscle arises from the edge of the scapula near its neck; the second head arises from the posterior surface of the os humeri; and the third or shortest, which lies immediately under the skin of the back part of the arm, arises from that part of the posterior part of the os humeri which is below the glenoid cavity. The three heads are united by a broad tendon, which covers the posterior part of the humerus, and is fixed into the upper and outer part of the olecranon ulnæ, and into the condyles of the os humeri. As these muscles take their origin from the trunk of the body, they may either move the arm upon the trunk of the body, or the trunk upon the arm. If the arm be forcibly drawn downwards, so as to hold a book below the arm, the latissimus dorsi and lower portion of the greater pectoral co-

operate. But, if the arm be raised, and a firm body be taken hold of, the body is drawn towards the arm, as when the legs are thrown upwards.

Epicondylo-Ulnalis, or *Anconeus.*

This muscle, which arises from the posterior part of the external condyle of the os humeri, and is inserted into a ridge on the outer and back-part of the ulna, assists the triceps in extending the fore-arm.

The places of the insertions of the muscles into the humerus merit the peculiar attention of the surgeon, from their influence upon the different fractures of this bone. Thus, when the neck of the humerus has been broken, the great pectoral muscle and teres major, and long head of the triceps, draw the lower portion of the broken bone inwards, and then upwards; and the upper portion of the bone is drawn outwards by the supra-spinatus and teres minor muscles. When the humerus has been broken transversely below the insertion of the deltoid muscle, the broken pieces of the bone are not displaced, the broken portions being kept together by the triceps muscle, and brachialis internus. But, if the fracture be oblique, the under portion of the broken bone is drawn upwards by the biceps flexor cubiti of the deltoid muscle and long head of the triceps. The olecranon ulnæ may be compared to the patella; and, like it, has sometimes been broken by the triceps extensor cubiti, which is inserted into it, though more frequently by external violence. When the olecranon has been detached from the body of the bone, it is always drawn upwards by the contraction of the triceps extensor muscle; and the detached portions are disjoined when the arm is bent. In the treatment of this fracture, it is the object of the surgeon to keep the broken pieces in contact with each other, by extending the fore-arm, and by bandages.

SECTION XII.

OF THE SUPINATOR AND PRONATOR MUSCLES.

THERE are two bones in the fore-arm, the ulna and radius. The former is moved in the flexion and extension of the fore-arm; the latter in the supination and pronation of the hand. There are two muscles by which *supination* is performed, and two pronator muscles also.

Supinator Muscles.

Humero-Super-Radialis, or *Supinator Radii Longus.*

This muscle lies immediately under the skin; it arises from a ridge of the os humeri above the external condyle of that bone; it is placed between the brachæus internus and short head of the triceps extensor cubiti, and is inserted, by means of a long tendon, into the carpal end of the radius, which it moves from within outwards upon the ulna. The extensor muscles of the thumb cross over the place of the insertion of this muscle.

Epicondylo-Radialis, or *Supinator Radii Brevis.*

This muscle lies deep; it takes its origin from the external condyle of the os humeri, from the outer upper part of the ulna, and from the interosseous ligament; it is covered, in part, by the brachialis internus, and by the tendon of the biceps flexor cubiti; it is wrapt around the upper and fore part of the radius, which it turns upon its axis.—The supinator muscles are counteracted by two pronator muscles.

Pronator Muscles.

Epitrochlo-Radialis, or *Pronator Radii Teres.*

This muscle, which is placed on the inner side of the tendon of the brachialis internus muscle, takes its origin from the internal condyle of the os humeri, and from the coronoid pro-

cess of the ulna; and, becoming gradually smaller, it passes under the supinator radii longus, extends across the upper end of the flexor muscles of the wrist, and is fixed into the interior and upper part of the radius, below the supinator radii brevis.

Ulno-Radialis, or *Pronator Radii Quadratus.*

This muscle, which lies close upon the interosseous ligament, extends between the carpal extremities of the ulna and radius.

The muscles of the fore-arm may occasionally act on the trunk of the body, when the fore-arm has been fixed. Thus, when the triceps extensor cubiti is thrown into action, the trunk of the body may be moved.

The brachialis internus is the antagonist of the triceps, but more limited in its action, on account of its greater shortness.

If the arm be fixed, the biceps and triceps may act on the scapula, and the scapula may be made to move on the head of the humerus. Thus we have been informed of a person, who placed a cane between his scapula, and grasped it, so that he could raise his body from the ground upon it; to do which, he put together the palm of his hands behind his back, in order fully to stretch the bicepates, and by acting with these muscles, he raised the scapula on the heads of the ossa humeri.

SECTION XIII.

MUSCLES OF THE HAND.

Muscles of the Carpus and Metacarpus.

The muscles of the carpus have been named *radial* or *ulnar*, according to the side of the fore-arm along which they pass; and *internal* or *external*, according to the condyle of the humerus from which they take their origin.

Two of the muscles of the carpus are *flexors*, and three *extensors* of the hand.

Epitrochlo-Metacarpeus, or *Flexor Carpi Radialis.*

This muscle, which is placed immediately beneath the fascia, proceeds from the internal condyle of the os humeri, and from the fore and upper part of the ulna: its long tendon passes through the fossa of the os trapezium, and is inserted into the fore and upper part of the metacarpal bone of the fore-finger.

By this muscle the wrist is not only bent, but the hand is thrown into a state of pronation.

Epitrochlo-Carpalis, or *Flexor Carpi Ulnaris.*

This muscle takes its origin from the fascia of the forearm, from the internal condyle of the os humeri, and from the inner side of the olecranon ulnæ. It passes along the inner side of the ulna, between the extensor carpi ulnaris at the back of the arm, and the flexor sublimis in the front of it, and is inserted into the os pisiforme. This muscle assists the former.

Humero-Super-Carpeus, or *Extensor Carpi Longior.*

This muscle arises immediately below the supinator radii longus, from the ridge above the external condyle of the os humeri. It passes along the radius, under the extensor muscles of the thumb, and its tendon is fixed down by the ligamentum carpi annulare, and is fixed into the upper and back part of the metacarpal bone of the fore-finger.

Epicondylo-Super-Metacarpeus, or *Extensor Carpi Brevior.*

The origin of this muscle is similar to that of the former, excepting that a few of its fibres are also connected with the capsular ligament of the joint; its tendon also passes under the annular ligament in the same groove with that of the former muscle; and is inserted into the upper and back part of the metacarpal bone of the middle finger.

The two last named muscles extend the wrist.

Ulno-Super-Metacarpeus, or *Extensor Carpi Ulnaris.*

This muscle arises from the external condyle of the os humeri, and from the middle of the ulna: its round tendon is inclosed in a sheath in a groove at the back-part of the carpal extremity of the ulna, and is at length fixed into the upper part of the metacarpal bone of the little finger.

This muscle extends the wrist, and draws the hand towards the little finger.

SECTION XIV.

MUSCLES OF THE FINGERS AND THUMB.

There are two flexor muscles common to the fingers, and only one extensor. There are two flexors, three extensors, an abductor, an adductor, and an opponens, proper to the thumb.

There is an extensor, a flexor, and an adductor of the fore-finger; and a flexor, an abductor, and an adductor, proper to the little finger. Besides these muscles, there are muscles between the bones of the fingers, called, from their situation, *interossei*, which move the fingers laterally.

Muscles common to the Fingers.

Epicondylo-Super-Unguialis, or *Extensor Communis Digitorum.*

This muscle, situated upon the posterior surface of the fore-arm, arises from the external condyle of the humerus: the fibres unite, and divide upon the back of the fore-arm into four tendons, which pass under the annular ligament of the wrist in a superficial groove of the radius, and are fixed into the posterior part of all the bones of the fingers.

By this muscle the fingers are extended. This muscle covers the extensors of the thumb and fore finger, and also the supinator radii brevis.

Epitrochlo-Phalangeus, or *Flexor Digitorum Sublimis Perforatus.*

This muscle takes its origin from the internal condyle of the os humeri, and from the coronoid process of the ulna, and also from the fore-part of the tubercle of the radius. The muscle which passes behind the pronator radii teres, the flexor carpi radialis, and palmaris longus, divides into four tendons, which pass under the anterior annular ligament, and are inserted into the second phalanx of the fingers; and at the first phalanx the tendons are perforated by those of the flexor digitorum profundus.

Palmo-Phalangei, or *Lumbricales.*

These four muscular slips are connected to the tendons of the last-named muscle; and at the under ends of the metacarpal bones they send off small tendons, which are fixed into the tendons of the interossei muscles, about the middle of the first phalanx.

These muscles have but little effect; they increase the power of the flexors of the fingers.

Ulno-Sub-Unguialis, or *Flexor Digitorum Profundus.*

This muscle arises from the upper part of the ulna, and from the interosseous ligaments; it is placed behind the flexor sublimis, and divides into four tendons, which are fixed into the upper part of the third phalanx of the fingers.

By the flexor sublimis, the second and first phalanges of the fingers are bent; and by the latter the third phalanx.

Muscles of the Thumb.

The superiority of the human hand is owing to the size and strength of the thumb, which may be made to oppose the fingers, in grasping substances. The thumb and fingers, owing to their number of joints, possess great flexibility, and are so constructed as to be accurately adapted to those substances we take hold of; and, as the length and size of the bones of the thumb and fingers gradually decrease, we can

lay hold of very minute substances, in which we are assisted by our nails.

Radio-Sub-Unguialis, or *Flexor Longus Pollicis Manus.*

This muscle is concealed by the flexor digitorum sublimis: it arises from the fore-part of the radius, and, from the interosseous ligament, passes under the annular ligament, and is fixed by a tendon which passes between the two sesamoid bones *, which are placed in the fore-part of the joint of the thumb, into the last joint of the thumb; which is bent by it.

Carpo-Phalangeus, or *Flexor Brevis Pollicis.*

This muscle arises from the os trapezoides, os magnum, and os unciforme; it lies under the abductor pollicis; it is divided into two portions by the flexor longus, and is fixed into the base of the first bone of the thumb and ossa sesamoidea: by this muscle the first joint of the thumb is bent.

Carpo-Metacarpalis, or *Opponens Pollicis.*

This muscle, which lies under the abductor pollicis, takes its origin from the os trapezium, and ligamentum carpi annulare, and is inserted into the under and fore part of the metacarpal bone of the thumb. This muscle brings the thumb inwards, and makes it oppose the fingers.

Carpo-Super-Phalangeus, or *Abductor Pollicis.*

This muscle is placed under the skin, and is the outermost portion of the mass which forms the ball of the thumb; it arises from the os trapezium and ligamentum carpi annulare, and is fixed into the outer side of the root of the first bone of the thumb. The use of the muscle is to draw the thumb from the fingers.

Metacarpo-Phalangeus-Pollicis, or *Adductor Pollicis.*

This muscle takes its origin from the metacarpal bone of

* Sesamoid Bones are sometimes found in the articulations between the metacarpus and fingers.

the middle finger, crosses the metacarpal bone of the fore-finger, and it is fixed into the root of the first bone of the thumb, on its inner side. By this muscle, the thumb is drawn towards the fingers.

The three extensor muscles of the thumb are situated on the back-part of the fore-arm, and are concealed by the extensor digitorum communis, and the extensor carpi ulnaris.

Ulno-Super-Metacarpeus Pollicis, or *Extensor Ossis Metacarpi Pollicis.*

This muscle takes its rise from the middle of the posterior part of the ulna, radius, and interosseous ligament. It passes obliquely over the radius, and is fixed into the os trapezium, and upper and back-part of the metacarpal bone of the thumb, which it extends.

Ulno-Super-Phalangeus Primus Pollicis, or *Extensor Primi Internodii Pollicis.*

This muscle, which arises from the back-part of the ulna, and from the interosseous ligament, and is fixed into the posterior part of the first bone of the thumb, tends to extend the first joint of the thumb.

Ulno-Super-Phalangeus Secundus Pollicis, or *Extensor Secundi Internodii Pollicis.*

This muscle takes it origin from the middle and back-part of the ulna, and from the interosseous ligament, and is inserted into the last joint of the thumb, which it extends.

Muscles proper to the Fore-Finger.

Ulno-Super-Phalangeus Primus Indicis, or *Indicator.*

This muscle arises from the middle and posterior part of the ulna, and the tendon of which is contained in the same sheath as the extensor digitorum communis: it is fixed into the posterior part of the fore-finger.

By this muscle the finger is extended, as in pointing.

Abductor Indicis.

This muscle lies under the skin of that portion of the back of the hand which is next to the thumb, and in the palm of the hand it lies under the muscles of the thumb. This muscle arises from the os trapezium, and from the upper and inner part of the metacarpal bone of the thumb, and is fixed into the outer and back-part of the first bone of the fore-finger. The use of this muscle is to draw the fore-finger towards the thumb.

Muscles of the Little Finger.

Carpo-Phalangeus Secundus, or *Flexor Parvus Minimi Digiti.*

This muscle, which lies on the inner side of the abductor minimi digiti, takes its origin from the outer side of the os unciforme, and from the annular ligament of the wrist, and it is inserted by a round tendon into the base of the first phalanx of the little finger. By this muscle the little finger is bent.

Carpo-Metacarpeus Minimi Digiti, or *Abductor Minimi Digiti Manus.*

This muscle, which lies immediately under the skin, arises from the os pisiforme, and annular ligament of the wrist, and its fibres extend along the metacarpal bone of the little finger, and are inserted into the inner side of the first phalanx. By this muscle the little finger is drawn from the other fingers.

Carpo-Metacarpeus Minimi Digiti, or *Adductor Minimi Digiti.*

This muscle, which is covered by the bellies of the abductor and flexor brevis minimi digiti, arises from the os unciforme, and is inserted by a tendon into the root of the first phalanx of the little finger. In the palm of the hand, this muscle is covered by the muscles of the thumb. By this muscle, the fore-finger is drawn toward the thumb, or the thumb is drawn towards the fore-finger.

Of the Muscles between the Fingers called Metacarpo-Phalangei Laterales, or *Interossei*.

There are two strata of interossei muscles, an external and internal.

These muscles take their origin from the sides of the metacarpal bones, and are fixed by slender tendons, into the tendinous expansions of the extensor digitorum communis.

By these muscles, the fingers are moved laterally, and they also assist in bending or extending the phalanges of the fingers.

There are four *interossei interni* in the palm of the hand.

The 1*st*, called *prior indicis*, takes its origin from the outer part of the metacarpal bone of the fore-fingers, and is inserted into the outer side of the first phalanx of that finger.

By this muscle, the fore-finger is drawn towards the thumb.

The 2*d*, named *posterior indicis*, arises from the root and inner side of the metacarpal bone of the fore-finger, and is inserted into the inner side of the first phalanx of the fore-finger.

By this muscle, that finger is drawn outwards.

The 3*d*, named *prior annularis*, arises from the root and outer side of the metacarpal bone of the ring-finger, and is inserted into the outer side of the first phalanx of the same finger.

By this muscle, the ring-finger is drawn towards the thumb.

The 4*th*, named *interosseus auricularis*, takes its rise from the root and outer side of the metacarpal bone of the little finger, and is inserted into the outer side of the first phalanx of the little finger.

By this muscle, the little finger is drawn outwards.

There are only three *interossei externi*, called *bicipites*: these are larger than the internal, and are situated between the metacarpal bones on the back of the hand.

Prior medii digiti, arises from the corresponding sides of the metacarpal bones of the fore and middle fingers, and is fixed into the inner side of the tendon on the back of the middle finger.

SECTION XV.

BURSÆ MUCOSÆ OF THE SUPERIOR EXTREMITIES.

Bursæ in the Vicinity of the Shoulder-Joint.

THERE are several bursæ around this joint.

There is a *bursa* which may be named *coraco-brachialis*, as it is situated between the origin of the coraco-brachialis muscle, the scapulo-radialis muscle, and the capsular ligament of the joint.

There is a *bursa*, under the head of the os humeri, between it and the tendon of the teres major muscle and that bone.

There is a *bursa* between the tendon of the latissimus dorsi and the os humeri.

There is a *large bursa* between the acromion scapulæ, the coracoid process, and capsular ligament of the shoulder-joint, and also a small bursa between the coracoid process and capsular ligament of the humerus; this, however, is sometimes wanting.

There is a *bursa* above the tendon of the infra-spinatus, and teres major muscle.

There is a *bursa* between the clavicle and coracoid process of the scapula.

There is a *bursa* between the subclavian muscle and first rib.

There is a *bursa* between the clavicle and coracoid process, where the former bone works on the coracoid process.

There is a *vaginal shaped bursa*, which incloses the tendon of the long head of the scapulo-radialis muscle: and there is a *very small bursa* placed under that part of the muscle which passes over the head of the os humeri: and a *bursa* is also placed under the tendon of the subscapularis muscle, which communicates with the cavity of the joint.

Bursæ Mucosæ situated near the Elbow-Joint.

There is a *bursa* between the tendons of the biceps bracheus internus, and anterior tubercle of the radius. The tu-

bercle of the radius is incrusted with cartilage, lined with the membrane of the bursa, and within the bursa there is a peloton of fat.

There is a *bursa* between the tendon of the biceps and the ligament which is common to the radius and ulna.

There is a *bursa* between the olecranon ulnæ and tendon of the triceps extensor cubiti.

Bursæ of the Inferior Part of the Fore-Arm and Hand.

There is a *large bursa* behind the flexor longus pollicis manus, between it and the fore-part of the radius, and capsular ligament of the wrist.

A *bursa* is placed behind the tendons of the flexor digitorum profundus, on the fore-part of the capsular ligament of the wrist; and, in some subjects, this communicates with the *very large bursa*, proper to the tendon of the flexor pollicis longus.

A *bursa* is placed between the tendon of the flexor carpi radialis and os trapezium.

There is a *bursa* between a tendon common to the extensor carpi radialis brevis, and extensor digitorum communis.

There is a very small *bursa* between the tendon of the flexor carpi ulnaris, and os pisiforme.

SECTION XVI.

MUSCLES OF THE PELVIS AND INFERIOR EXTREMITIES.

In a former part of this work, the peculiarities of the human pelvis, and of the bones of the inferior extremities, which bear an immediate relation to the muscles connected with that part of the skeleton, were described. The largest glutæi muscles, which distinguish man from all the inferior animals, and by which the pelvis is extended on the thighs, and kept in that state in the erect position of the body, and which counteract the natural tendency of the body to fall forwards, take their rise from the large and expanded wings of the pelvis.

But in the inferior animals, the glutæi muscles are of very small size, and hence they can scarcely be said to have hips.

The extensor muscles of the knee are also of singular strength in man, and are not inserted so low into the tibia as in the monkey tribe; and hence he is capable of more fully extending his knee. These muscles also bring the thigh forwards on the leg, which is essential to the mode in which men walk and run. Man is also distinguished from the inferior animals by the greater size of the calves of his legs, the muscles of which counteract the tendency of the weight of the body to bend the leg in our erect position, and, in raising the heel bone, are powerful agents in progressive motion.

In short, the disposition of the muscles of the inferior extremities, shews, that man is intended for the erect position, and that he only is capable of maintaining his body in that position for a considerable time, without great fatigue.

Ilio-Costalis, or *Quadratus Lumborum.*

This muscle takes its origin from the lateral and posterior half of the spine of the os ilium, between the origins of the psoas magnus, and transversalis abdominis: it is inserted into the transverse processes of the lumbar vertebræ, into the posterior part of the last rib, and into the side of the last vertebræ of the back.

By this muscle, the last rib is pulled down, as in difficult expiration; and when the muscles of both sides are at the same time thrown into action, the loins are bent.

SECTION XVII.

OF THE TENDINOUS APONEUROSIS OF THE INFERIOR EXTREMITY, AND MUSCLE PROPER TO IT.

At present it is proposed to describe in very general terms the tendinous aponeurosis of the inferior extremity.

The fascia of the thigh, which has been called *fascia lata*, is made up partly of tendinous, and partly of ligamentous fibres.

It is smooth on its external surface, considerably thicker on the outer than on the inner side of the thigh, and not only covers, but also enters between the muscles of the thigh.

The upper part of this fascia, which is very intimately interwoven with the crural arch, (in a manner to be afterwards more fully described), is covered by a very thin tendinous fascia, called the *glandular fascia.*

The large vein, called *vena saphœna major*, runs between the fascia lata and the skin, and sinks beneath *a crescent-like fold of fascia*, to join the deep femoral vein.

There are many small nerves which ramify above this fascia of the thigh, which are derived from the *lumbar* and *anterior crural nerves;* and also a number of lymphatic glands, and lymphatic vessels, which appear like lines of a whitish colour, and enter the inguinal lymphatic glands, at the upper and inner part of the thigh.

This fascia is connected to the crural arch; to the sacro-sciatic ligaments; to the tendon of the glutæus maximus and tensor vaginæ femoris; to the linea aspera, condyles of the thigh-bone, and patella; it is attached also to the upper parts of the tibia and fibula, and, being continued, forms the fascia of the leg.

This fascia of the leg is connected to every projecting part of the bones, becoming thinner towards the under part of the leg, and where it passes over the ankle. It forms a strong *annular* or *transverse ligament*, which extends from the outer ankle and neighbouring part of the os calcis, and is fixed to the malleolus internus and os naviculare. This ligament binds down the tendons of the extensor muscles.

There is a muscle proper to the upper part of the fascia, called

Ilio-Femoralis, or *Tensor Vaginæ Femoris.*

This muscle arises from the external part of the anterior superior spinous process of the os ilium, and is fixed into the fascia, where it covers the upper and outer side of the thigh, a little below the trochanter major.

The use of this muscle is to stretch the fascia, and to assist in the abduction of the thigh.

The tendinous fascia of the sole of the foot, which is very thick and strong, extends between the prominent and anterior parts of the os calcis, and to the heads of the metatarsal bones, to which it is fixed by its bifurcated extremities, between which the tendons of the flexor muscles pass: hence is well suited to give protection to the muscles, bloodvessels, and nerves of the sole of the foot.

SECTION XVIII.

MUSCLES INSERTED INTO THE TROCHANTER MAJOR.

The muscles inserted into the trochanter major, move the thigh-bone within the acetabulum, in such a manner as to turn the toes outwards, or in the contrary direction.

Sacro-Femoralis, or *Glutæus Maximus*.

This very thick and strong muscle, which lies under the skin, and constitutes the greater share of the hips, which are proportionally much larger in man than in the inferior animals, takes its origin from the posterior edge of the os ilium, from the lateral surface of the os sacrum, and from the posterior part of the sacro-sciatic ligaments. The fibres of the muscle are collected into fasciculi, which proceed forwards and downwards, and terminate in a broad and flat tendon, which slides over the trochanter major, and is fixed into the posterior part of the linea aspera of the thigh-bone, below the great trochanter, and into the fascia lata of the thigh.

By this muscle, the ball of the os femoris is rotated outwards.

The Hottentot women have a singular projection over the buttocks, which, according to Dr Somerville, consists chiefly of fat, of three or four inches in thickness, which is interposed between the skin and muscles; and what is very remarkable,

able, this cushion of fat, according to Mr Barrow, is not formed until the first pregnancy.

The glutæus is one of the most powerful muscles by which the body is kept erect; and counteracts the effect of the weight of the body, which tends to make the ossa innominata move backwards on the thigh-bones.

Ilio-Trochanterus major, or *Glutæus Medius.*

This muscle, which lies under the former, excepting at its anterior part, where it is covered only by fascia, arises from the circumference and outer edge of the dorsum of the os ilium; and its radiated fibres are collected and inserted into the upper part of the trochanter.

By the above, and the two following muscles, the thigh is rotated outwards.

Ilio-Trochanterus minor, or *Glutæus Minimus.*

This muscle arises from the anterior and inferior part of the os ilium; the fibres of the muscle run in a radiated manner, and are inserted by a thin and broad tendon, into the anterior and superior part of the trochanter major.

Sacro-Trochanterus, or *Pyriformis.*

This muscle arises from the inner side of the second, third, and fourth pieces of the os sacrum; passes out of the pelvis, above the upper sacro-sciatic ligament, and is fixed by a strong round tendon, into the top of the great trochanter.

This muscle is covered by the glutæus maximus, and medius muscles.

Sub-Pubo-Trochanterus, or *Obturator Internus.*

This muscle extends between the internal part of the membrane which fills up the foramen obturatorium, and the great trochanter. The inside of this muscle is covered by a portion of the levator ani; and its tendon passes in a groove between the tuberosity of the ischium and spinous process of that bone, and revolves upon the posterior edge of the ischium, between the two following muscles.

Ischii-Trochanteri, or *Gemini*.

These muscles, which lie below the pyriform muscle, and above the quadratus femoris, take their origins from the posterior edge of the ischium, and are inserted into the top of the great trochanter. They are united by a tendinous sheath; and, between them, the tendon of the obturator internus plays.

Ischio-Trochanterus, or *Quadratus Femoris*.

This muscle, which is placed under the preceding, extends between the tuberosity of the os ischium, and posterior edge of the great trochanter, and rotates the thigh from within outwardly. This muscle is concealed by the glutæus maximus; and lies under the inferior gemellus muscle.

SECTION XIX.

THE MUSCLES INSERTED INTO THE TROCHANTER MINOR, WHICH ARE FLEXORS OF THE THIGH.

Præ-Lumbo-Trochanterus, or *Psoas Magnus*.

This muscle arises from the sides of the transverse processes of the lumbar and last dorsal vertebra; it passes along the brim of the pelvis, and is inserted, by means of a tendon, into the lesser trochanter. In some instances, we meet with a *Psoas parvus muscle*, which takes its rise from the last dorsal and first lumbar vertebra, and is fixed, by a long slender tendon, into the brim of the pelvis, where the os pubis and os ilium are united.

Ilio-Trochantinus, or *Iliacus Internus*.

This muscle, which fills up the concave surface of the os ilium, takes its origin from the transverse process of the lowest lumbar vertebra, and also from the inner surface of the os ilium; it passes along the brim of the pelvis, and is fixed, along with the former muscle, into the lesser trochanter. This muscle is covered by a strong fascia, called Fascia Ilia-

ca, which is fixed into the posterior part of the crural arch; and a part of the fascia is continued behind the femoral vessels, and forms the posterior part of the crural sheath. The iliacus internus and psoas muscles not only bend the thigh, but also, from passing around the bone, when the toes are turned inwards, their first effect is to give a degree of rotation to the thigh. These muscles are chiefly counteracted by the glutæus maximus.

Pubo-Femoralis, or *Pectinalis.*

This muscle, which arises from the superior margin of the os pubis, and forms a part of the brim of the pelvis, is fixed, by a thin tendon, into the trochanter minor, and linea aspera below it.

The following muscle draws the thighs inwards, as in riding on horseback, and towards each other.

Sub-Pubo, Sub-Pubi, Ischii-Femorales; or *Triceps Adductor Femoris.*

The first portion arises from the symphysis pubis, between the pectinalis and gracilis muscles; the second from the descending branch of the os pubis, behind the other two heads, forming a broad flat muscular septum between the muscles on the fore and back of the thigh; and the third from the tuberosity of the ischium, and lying under the origin of the longest head and pectinalis muscles. These muscles are fixed into the whole length of the linea aspera.

The three last muscles are counteracted by the

Sub-Pubo-Trochanterus Externus, or *Obturator Externus.*

This muscle, which covers the foramen obturatorium, is covered in front by the pectinalis and triceps, and behind by the quadratus femoris: arises from the edge of the obturator hole, and is fixed into the trochanter major. The thigh-bone may be not only bent and extended, but also rotated. If the thigh be in the same line with the body, and we wish to bend it, we throw into action the quadratus femoris, the pyriformis, gemini, and obturator muscles, and also the iliacus

internus and psoas; and, by the tensor vaginæ femoris, the thigh-bone is replaced. But, when the thigh-bone is rolled or bent, a curious interchange takes place as to the action of the muscles; the rotator muscles become the abductors, and the abductors the rotator muscles. It may be also observed respecting the muscles of the thigh, that when the leg is more fixed than the trunk of the body, the muscles of the thigh act upon the trunk of the body; they rotate the pelvis upon the top of the thigh-bone.

SECTION XX.

MUSCLES OF THE LEG.

The leg is extended by four muscles, the rectus, vasti and cruræus, which are inserted into the patella or rotula, by a common broad tendinous sheath.

Ilio-Rotularis, or *Rectus Anterior Cruris.*

This muscle arises from the inferior and anterior spinous process of the os ilium, and from the capsular ligament of the joint, and extends along the whole anterior part of the thigh. The tendinous origins of this muscle are covered by the sartorius and tensor vaginæ femoris; and the fleshy belly at its uppermost part is covered by the sartorius muscle. This penniform muscle is fixed into the upper extremity of the patella. The three other *extensors of the leg* have been described by some authors under the name of *Trifemorales;* they lie under the rectus, seem to constitute one mass of flesh, and cannot be separated without cutting a few muscular fibres.

Middle of the Trifemoro-Rotularis, or *Cruralis.*

This muscle, which is situated under the preceding, arises from the whole anterior surface of the thigh-bone, and is fixed into the posterior surface of the tendon of the rectus muscle, and lies between the two following muscles, which in part cover it.

Outer Share of the Trifemoro-Rotularis, or *Vastus Externus.*

This muscle, which occupies the outer side of the thigh-bone, arises from the anterior surface of the root of the trochanter major, and from the outer edge of the linea aspera, and is inserted into the external surface of the tendon of the rectus cruris.

Inner Share of the Trifemoro-Rotularis, or *Vastus Internus.*

This muscle fills up the inner part of the thigh-bone, and arises from the root of the trochanter minor, from the upper edge of the linea aspera, and from the whole internal surface of the thigh-bone, and it is inserted into the lateral surface of the tendon of the rectus cruris.

My Father remarks *, that the direction, length, and number of the fibres, in such muscles, had not been sufficiently attended to by anatomists and surgeons; and that, in many instances, the breadth of these muscles had been mistaken for their length; that, in consequence of this inattention, they would find Mr Louis † attempting to discard the double incision of the soft parts in the amputation of the thigh, though, from the obliquity and shortness of the muscular fibres which cover the thigh-bone, this improvement of Cheselden is more essential than in the amputation of the humerus, where the fleshy fibres, though oblique, are proportionally longer, and of course their retraction greater.

The middle and greater part of the tendon, common to the four extensor muscles of the leg, has sometimes been lacerated; in which case, the torn portions should be kept in contact, by extending the patient's limb, and by bandaging. My Father used to make mention of the case of a patient, who, though 74 years of age, could, at the end of three weeks, walk up and down stairs, without being obliged to bring both feet

* See Observations on the Oblique Muscles, Phil. Trans. of Edin. vol. iii. p. 251.

† Acad. Roy. de Chir. tom. ii. p. 357.

on the same step. In another case, the cure was not so complete, as the patient could not be prevailed upon to remain in bed, and to follow the directions given to him. A third patient, a man of 50 years of age, had been dissuaded from extending and bandaging his knee; and, when my Father saw him, five weeks after the tendon had been torn, there was a deep hollow to be felt above the patella, and he was lame. In none of these cases was the knee rendered stiff by extending it, and keeping it motionless.

The extensor muscles are counteracted by the six following strong *flexor muscles.*

Ischio-Peroneus, or *Biceps Flexor Cruris.*

This muscle consists of two parts; the longer is derived from the outer part of the tuberosity of the os ischium, in common with the semitendinosus, is covered by the glutæus maximus muscle, and lower down the thigh lies under the fascia, and the other from the middle of the linea aspera of the os femoris: below the insertion of the glutæus maximus both parts unite, and are fixed into the outer part of the head of the fibula.

This muscle forms the outer hamstring.

Ischio-Sub-Tibialis, or *Semimembranosus.*

This semipenniform muscle takes its rise from the upper and outer parts of the tuberosity of the os ischium, and the fibres are connected to a flat tendon, which is inserted into the upper and inner side of the tibia.

Ischio-Prætibialis, or *Semitendinosus.*

This muscle also arises from the tuberosity of the os ischium, and is inserted, by means of a strong rounded tendon, into the upper and inner part of the tibia, about three inches from the knee.

The leg is not only bent backwards, but also inwards, by this muscle.

This and the preceding muscle form the larger share of the inner hamstring.

Ilio-Præ-Tibialis, or *Sartorius*.

This muscle, which arises from the anterior and superior spinous process of the os ilium, between the crural arch and tensor vaginalis femoris, passes for some way upon the rectus cruris, then across the vastus internus, the triceps and abductor magnus, or in a spiral direction across the fore-part of the thigh, and behind the inner condyle of the thigh-bone, and is inserted into the upper and inner part of the tibia by a broad thin tendon, immediately below the anterior tubercle of the tibia, above the tendons of the gracilis and semitendinosus.

If we pull the sartorius when the leg is straight, the leg is drawn close on the thigh, but not bent; but after the leg has been bent by its flexor muscles, the sartorius, being thrown behind the joint of the knee, is employed as a flexor, and, on account of the length of its fibres, its action is considerable.

By this muscle the leg is bent obliquely inwards on the thigh.

Pubo-Prætibialis, or *Gracilis*.

The origin of this muscle is from the lower part of the symphysis pubis, on the inner side of the origins of the triceps abductor femoris: it decends along the inner side of the thigh, to be inserted into the tibia, below the sartorius muscle.

This muscle assists in the flexion of the knee, after it has been bent by the flexors of the leg.

Poplito-Tibialis, or *Popliteus*.

This muscle is concealed by the gastrocnemius; it extends between the external condyle of the thigh-bone, the back-part of the capsular ligament of the joint, and the internal and upper part of the tibia.

By this muscle, the leg is not only bent; but when bent it is rolled inwards.

The muscles above described as the flexors and extensors of the leg become its rotators, when the leg is bent, by acting alternately. Thus the internal and external flexors of the leg, the

semitendinosus and semimembranosus, acting alternately with the biceps, rotate the leg; and upon the weight of the body being thrown upon the leg, the same muscles become muscles of the thigh, or they bend and extend the thigh upon the leg, as in rising from a chair the legs are drawn backwards, or beneath the body, by which we act more firmly and securely in raising the thigh on the leg.

The insertion of the various muscles into the thigh-bone merits the particular attention of the surgeon, because the contraction of these muscles is a cause of the displacement and shortening of the limb in cases of fracture. The degree of the displacement varies according to the seat of the fracture. In general the undermost portion of the broken bone is drawn upwards by the muscles on the back-part of the thigh. If the fracture be immediately below the trochanter minor, the iliacus internus and psoas muscles, fixed into that process of the thigh-bone, pull the upper portion upwards, and, at the same time, rotate it outwards. If the fracture be near to the middle of the thigh-bone, the triceps abductor femoris will draw towards each other the broken extremities of the bones; and if the fracture be immediately above the condyles, the under portion is drawn downwards by the soleus, plantaris, and gastrocnemii muscles.

Much has been written as to the comparative advantages of placing a broken thigh-bone in a bent or extended position. Mr Pott highly recommended the half bent position, and that the limb should rest on its outer side, on the trochanter major, on the supposition, that the broken portions of bone would not be disjoined, the muscles of the thigh being thus in the middle state between the complete flexion and extension; whereas, by the extended position, some of the muscles are relaxed, and others are kept on the stretch.

But the mobility of the leg, and weariness resulting from lying on the side, for the length of time necessary to the cure, are strong objections to Mr Pott's method.

The French surgeons have, therefore, lately recommended, that the patient should lie on his back, and with the broken limb xetended; which is not only less irksome to him, but also

more convenient for the application of the apparatus, necessary for the support and steadiness of the limb, during the cure, while, at the same time, there is less chance of the broken pieces being separated from each other, by the involuntary actions of the muscles.

SECTION XXI.

MUSCLES OF THE ANKLE OR TARSUS, AND OF THE METATARSUS.

The muscles which move the foot, may be divided into three classes; viz. 1. Those which bend the foot. 2. Those which extend the foot by the medium of the tendo Achillis, and are the principal agents in walking, running, dancing, &c. 3. Those which lift the foot to either side.

The flexion of the foot with respect to the leg, or of the leg with respect to the foot, is accomplished by two muscles.

Tibio-super-Tarseus, or *Tibialis Anticus.*

This muscle lies under the tendinous fascia of the leg, on the fibular side of the spine of the tibia: it arises from the fore-part of the tibia, and from the interosseous ligament: its tendon passes below the annular ligament of the ankle-joint over the astragalus and os naviculare, and is fixed into the os cuneiforme internum and metatarsal bone of the great toe, by a tendon, the insertion of which is concealed by the abductor flexor brevis of the great toe.

Tibio-sub-Tarseus, or *Tibialis Posticus.*

This muscle, which is covered at its lower part by the flexor longus digitorum pedis, and by the flexor longus pollicis pedis, takes its origin from the posterior surface of the tibia, fibula, and interosseous ligament; and its fibres are disposed obliquely in respect to a middle tendon, which passes

behind the inner ankle, through a groove in the tibia, and is fixed into the os naviculare.

By this muscle the inner side of the foot is raised.

Of the Muscles which arise from the Perone, or Fibula.

Peroneo-Tarseus, or *Peroneus Longus.*

This muscle is placed between the outer part of the extensor longus digitorum pedis, and the edge of the soleus; it arises from the fore-part of the head of the fibula, and from the outer-part of the same bone.

The muscular fibres are fixed obliquely into the tendon, like the plumage of a pen into its stalk. The tendon of this muscle is lodged in a groove, formed by the malleolus externus; it passes across the sole of the foot in a groove in the cuboid bone, and is fixed into the outside of the metatarsal bone of the great toe and os cuneiforme internum.

By this muscle the foot is extended, and the inner edge of it turned downwards.

Peroneo-Metatarseus Magnus, or *Peroneus Brevis.*

This muscle takes its rise between the extensor longus digitorum pedis and peroneus longus, and from the outer part of the fibula: the fibres are fixed obliquely into the tendon which passes behind the outer ankle, in the same sheath with the preceding muscle, and is fixed into the external part of the metatarsal bone of the little toe.

The use of this muscle is to pull the outer edge of the foot upwards.

Some authors have described a *Peroneus tertius*, but that muscle I consider as a part of the extensor longus digitorum.

By the weight of the body, the leg is bent forwards on the foot; to obviate which there are *three very powerful extensor muscles*, which compose the calf of the leg, and which act upon the foot by the medium of the tendo Achillis.

Bi-Femoralis Calcaneus, or *Gastrocnemius*.

This muscle arises between the hamstrings; it consists of two strong heads, which are connected with the upper and back parts of the condyles of the thigh-bone; a little below, the fleshy bellies are united in a middle tendon, which is joined to that of the following muscle. The internal belly is the longer. The muscular substance of this muscle is not equally long in the person of the African Negro as in the European; yet the muscle produces as great an effect. It forms a considerable share of the calf of the leg.

Tibio-Calcaneus, or *Soleus*.

This compound penniform muscle rises from the posterior and upper surface of the tibia and fibula. The flesh of this muscle is in part covered by the tendon of the former muscle; and at the lower part of the leg, the belly of this muscle forms a prominent swelling under the tendon of the former muscle, or forms the lower part of the calf of the leg.

The tendo Achillis has often been lacerated, by a violent and sudden effort of the gastrocnemii muscles, in dancing; or sometimes it has been divided by a cutting instrument.

In the museum of the University, there is a specimen, in which the lacerated tendon had been reunited; the cure had been perfect, but notwithstanding that circumstance, there is an obvious enlargement of the tendon at the place where it had been torn.

My grandfather, who had lacerated his own tendo Achillis, has published a full account of his own case, and of sixteen others which had fallen under his notice: he has described most particularly the mode of treatment, which consists chiefly in relaxing the gastrocnemius muscle by bending the leg, and keeping it in that position during the cure. My Father used to observe in his Lectures, that he had met with several cases, in which a partial laceration of the belly of the gastrocnemius muscle had been mistaken for a sprain of the ankle or laceration of the tendo Achillis. Such cases are to be treated in the same manner as when the tendo Achillis has been torn.

Femori-Calcaneus, or *the Plantaris.*

This muscle arises from the upper and back-part of the external condyle of the thigh-bone, and from the capsular ligament of the joint; and it is concealed by the outer head of the gastrocnemius. The belly of this muscle is not above three or four inches long.

From this muscle, a thin tendon descends between the inner heads of the gastrocnemii muscles, which is fixed into the inner edge of the tendo Achillis, and into the posterior part of the os calcis. This muscle is sometimes awanting.

SECTION XXII.

MUSCLES OF THE TOES.

There are extensor, flexor, abductor and adductor muscles proper to the toes. The extensor muscles of the toes are three in number; viz.

Peroneo-Super-Unguialis, or *the Extensor Longus Digitorum Pedis.*

This muscle, which lies under the tendinous fascia, and between the tibialis anticus and peroneus longus, to both of which it is connected by many tendinous fibres, takes its rise from the outer part of the head of the tibia, from the fibula, and from the interosseous ligament. Below the middle of the leg, it splits into four tendons, which in their course pass under the annular ligament at the ankle joint, are inserted into the root of the first phalanx of each of the four small toes, and are expanded over the upper side of the toes, as far as the last phalanx.

Calcaneo-Super-Unguialis, or *Extensor Brevis Digitorum Pedis.*

The belly of this muscle, which lies under the tendons of the extensor longus digitorum pedis and peroneus brevis,

crosses these, and arises from the upper and anterior part of the os calcis, from the os cuboides and astragalus; it then divides into four distinct muscles, which are inserted into the first phalanx of the great toe, and into all the other toes, excepting the little toe.

Peroneo-Super-Unguialis, or *Extensor Longus Pollicis Pedis.*

This muscle, which is hid between the tibialis anticus, and extensor digitorum longus, takes its origin from the fibula and interosseous ligament: its tendon passes over the forepart of the astragalus and os naviculare, and is fixed into the base of the first and second phalanges of the great toe.

This muscle not only extends the great toe, but also bends the ankle.

There are also *three flexor muscles* of the toes; viz.

Tibio-Subunguialis, or *Flexor Longus Digitorum Pedis.*

This muscle, which lies under the soleus, arises from the posterior and flattened portion of the tibia; below the *soleus muscle*, the fibres pass obliquely into a tendon, which is situated on the posterior edge of the muscle. The tendon is lodged within a groove behind the inner ankle, and bound down by a strong ligament.

This muscle divides in the sole of the foot into four tendons, which pass through slits in the tendons of the flexor digitorum brevis, and which are inserted into the last joint of the lesser toes.

By this muscle all the joints are bent, but chiefly the last joint.

Flexor Digitorum Accessorius, or *Massa Carnea Sylvii.*

This broad and flat muscle, which is connected by two portions to the os calcis, is fixed into the tendons of the preceding muscle, and assists in bending the toes.

Planto-Sub-Phalangei, or *Lumbricales.*

The lumbricales are four thin portions of muscles, which

are fixed to the tendons of the flexor profundus, the inside of the first joint of the four small toes, and the tendinous expansion which is derived from the extensor muscles which cover the upper part of the toes.

These muscles increase the extent of the flexion of the toes.

Calcaneo-Sub-Unguialis, or *Flexor Brevis Digitorum Pedis Perforatus.*

This short muscle, which arises from the inferior and anterior part of the os calcis, and from the aponeurosis plantaris, splits into four small tendons, which give passage to the tendons of the long flexor; and are fixed into the second phalanx of the four small toes.

Besides the muscles enumerated in the preceding pages, the following are proper to the great and little toes, viz. calco-sub-phalangeus, or the abductor pollicis; metatarso-sub-phalangeus transversalis pedis, or transversalis pedis; metatarso-sub-phalangeus pollicis, or abductor pollicis; tarso-phalangeus, or flexor longus pollicis pedis; tarso-sub-phalangeus pollicis, or flexor brevis pollicis, calco-sub-phalangeus minimi digiti, or abductor minimi digiti; tarso-sub-phalangeus minimi digiti, or flexor brevis minimi digiti.

Tarso-Phalangeus, or *Flexor Longus Pollicis Pedis.*

This long flexor muscle of the great toe arises from the posterior part of the fibula. It is covered by the soleus, and is placed between the flexor longus digitorum, and the peroneus longus. The tendon of it passes through a groove in the tibia, then through a groove in the astragalus, crosses the sole of the foot, and is inserted into the last joint of the great toe.

Calco-Sub-Phalangeus-Pollicis, or *Abductor Pollicis Pedis.*

This muscle takes its rise from the lower and inner part of the heel-bone, and from that bone by a tendon, where it joins with the os naviculare; it is inserted into the os sesamoideum internum, and root of the first joint of the great toe.

By this muscle the great toe is pulled from the others.

Metatarso-Sub-Phalangeus-Transversalis Pollicis, or *Transversalis Pedis.*

This muscle takes its rise from the metatarsal bone of the little toe; crosses over the anterior extremities of the other metatarsal bones, and is inserted into the fore-part of the metatarsal bone of the great toe, and into the internal sesamoid bone.

By this muscle the foot is made narrower, the outer and inner toes being drawn towards each other.

Metatarso-Sub-Phalangeus Pollicis, or *Adductor Pollicis.*

This muscle takes its origin, by a long tendon, from the under part of the os calcis, os cuboides, and os cuneiforme externum, and root of the metatarsal bone of the second toe: it is divided into two portions, which are inserted into the external os sesamoideum, and root of the metatarsal bone of the great toe.

By this muscle, the great toe is pulled towards the other toes.

Tarso-Sub-Phalangeus Pollicis, or *Flexor Brevis Pollicis.*

This muscle extends between the fore and under part of the os calcis, and the external sesamoid bone, and root of the first bone of the great toe.

By this muscle the first joint of the great toe is bent.

Calco-Sub-Phalangeus Minimi Digiti, or *Abductor Minimi Digiti.*

This muscle extends between the under protuberance of the os calcis, the root of the metatarsal bone of the little toe, and the outer part of the root of the first bone of the little toe.

By this muscle the little toe is drawn outwards.

Tarso-Sub-Phalangeus Minimi Digiti, or *Flexor Brevis Minimi Digiti.*

This muscle extends between the cuboid bone, the outer and back part of the metatarsal bone of the little toe, and the

anterior extremity of the metatarsal bone, and root of the first bone of the little toe.

This muscle assists in bending the little toe.

In the foot there are also two strata of interossei muscles, viz. three *interossei interni*, placed in the sole of the foot, which move the three lesser toes towards each other. There are four *interossei externi*, which are larger than the internal, and bicipites, which separate the toes from each other.

SECTION XXIII.

OF THE BURSÆ OF THE INFERIOR EXTREMITIES.

THE *Bursæ Mucosæ* which appear in a fore view of the inferior extremity, are,

A *very large bursa mucosa* between the iliacus internus and psoas muscles, and the capsular ligament of the thigh-bone.

There is likewise a *bursa* between the tendon of the pectineus and thigh-bone.

And also a small *bursa mucosa* between the glutæus medius and trochanter major; and behind it the tendon of the pyriformis is inserted.

There is a *bursa mucosa* between the tendon of the glutæus minimus and trochanter major.

There is a *bursa mucosa* between the glutæus maximus and vastus externus.

There is a *large bursa mucosa* behind the tendon of the extensors of the leg.

There is a *bursa mucosa* behind the ligament which joins the patella to the tibia; and a large fatty pelleton hangs down into the cavity of the bursa.

There is a *large bursa mucosa* behind the tendon of the sartorius, and behind the tendons of the gracilis and semitendinosus, covering the inner fore part of the tibia.

There is a *bursa mucosa* between the tendon of the tibialis anticus, and under part of the tibia and ligament of the ankle.

There is a *bursa mucosa* between the tendon of the extensor pollicis pedis longus, and the tibia and ligament of the ankle.

There is a *bursa mucosa* for the tendons of the extensor digitorum communis longus, between them and the tibia and ligament of the ankle.

Bursæ Mucosæ in the Vicinity of the Knee-Joint

There is a *large bursa mucosa*, placed between the tendons of the extensores cruris and the fore-part of the thigh-bone, which is separated from the cavity of the joint of the knee, by a partition formed by the membrane of the bursa and inner layer of the capsular ligament, joined together by cellular substance. This bursa, in persons advanced in life, often communicates with the cavity of the knee-joint.

There is a *bursa* between the ligament which joins the patella to the tubercle of the tibia, and the upper fore-part of the tibia.

The Bursæ Mucosæ which appear in the Back-View of the Inferior Extremity.

There is a *bursa mucosa* between the glutæus medius and pyriformis; between the obturator muscle and os ischium; between the obturator internus, gemini, and capsular ligament of the thigh-bone, and between the tendon of the glutæus maximus and root of the trochanter major.

There are *two small bursæ mucosæ* between the tendon of the glutæus maximus and thigh-bone.

A *bursa mucosa* occurs between the tendons of the semimembranosus, and gemellus, and the ligament of the knee.

A *small bursa* is placed within the former bursa, from which there is a passage into the cavity of the joint of the knee *.

There is a *bursa mucosa* between the inner side of the tendon of the semimembranosus and the lateral internal ligament of the knee, from which there is a passage making a communication with the joint of the knee.

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* Vide Monro on the Bursæ Mucosæ.

A *bursa* is placed under the popliteus muscle, which frequently communicates with the cavity of the joint of the knee.

There is a *large bursa mucosa* common to the tendons of the peronei muscles.

A *bursa* is proper to the tendon of the peroneus brevis.

A *bursa mucosa* is placed between the tendo Achillis and the os calcis; and there is a pelleton of fat, which projects into the cavity of the bursa.

A *bursa mucosa* intervenes between the flexor pollicis longus and the os calcis.

There is a *bursa* between the flexor digitorum longus communis, and the tibia and os calcis.

A *bursa* is placed between the tendon of the tibialis posticus, and the tibia and astragalus.

Bursæ Mucosæ in the Sole of the Foot.

There is a second *bursa mucosa* for the tendon of the peroneus longus.

There is a *bursa mucosa* common to this tendon, and the tendon of the flexor digitorum pedis communis longus profundus.

There are *five bursæ mucosæ* of the flexor tendons, which begin a little above the first joint of the toes, and extend to the root of the third phalanx or insertions of the tendons into the bones.

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PART IV.

OF THE STRUCTURE AND FUNCTIONS OF THE SEVERAL PARTS OF THE ALIMENTARY CANAL, AND OF THE ORGANS OF MASTICATION, DEGLUTITION, CHYMIFICATION, AND CHYLYFICATION.

CHAP. I.

GENERAL OBSERVATIONS UPON THE STRUCTURE AND FUNCTIONS OF THE ORGANS OF DIGESTION.

By *Digestion*, is understood that process by which the food received into the system undergoes the alteration necessary for repairing the waste, and sustaining the strength of the animal, during the exercise of its several functions.

To support the strength of the body, animals are provided with digestive organs; and are at the same time stimulated, by the sensations of hunger and thirst, to take in the proper supply of aliment.

The food is separated into its useful and useless parts within the stomach and intestines; and the nutritious part, called Chyle, is absorbed by small vessels, which, from the colour of the fluid they contain, have been called *Lacteal.*

It is the office of these vessels to convey the lacteal fluid to be mixed with the blood; and during the passage of the blood through the lungs, the chyle and blood are intimately incorporated with each other; or at the lungs, the process of digestion is completed.

In considering the nature of digestion, it is necessary to examine,

1. The preparation which the food undergoes before it enters the stomach.

2. The changes it undergoes in the stomach and intestines.

3. The separation of the nutritious and excrementitious parts; and the effect of the addition of the bile and pancreatic liquor to the alimentary mass.

4. The mode of conveyance of the nutrition or chyle into the blood.

5. The changes which it undergoes after its mixture with the general circulating fluid.

6. The nature of the secreted fluids, and the effects of the different secretory and excretory organs.

Such an extensive view of the subject, beside unfolding the anatomical structure and particular use of the different organs, is calculated to exhibit an instructive physiological view of the relations established between them, and of the subserviency of all the functions of the animal economy to one another.

Animals receive their food into an *internal receptacle, or stomach, situated within the body.* Vegetables are nourished by their roots, and *by the vessels which open upon their surfaces.* HIPPOCRATES has remarked, "Ut terræ arboribus, "ita animalibus ventriculus." But the observation of HIPPOCRATES is not universally just; for in some of the inferior animals, as the hydatids which are sometimes found in the human body, a mouth is not visible.

A relation is established between the external form of an animal, and its organs of sensation, mastication, and digestion. It is obvious, that if an animal did not possess the means of distinguishing and selecting that kind of food which is most proper for it, it would cease to exist. Hence the remarkable differences in the external form, and internal organization of carnivorous, graminivorous, and omnivorous animals, or those that feed alike upon animal and vegetable food. Carnivorous animals have sharp teeth, of a conical form, or a strong beak, for dividing their prey, an acute sense of smell, feet armed with claws, and capable of running or flying quickly, and are sufficiently strong to kill their prey.

Animals that are vegetable eaters have hoofed feet; flat grinding teeth; a very long alimentary canal; a very large stomach, or several stomachs.

The shape and movements of the human jaw; the structure and form of the human teeth; the organization, length, and convolutions of the alimentary canal,—all clearly shew that man is intended to be *omnivorous*, or to live both on vegetable and animal food; but though omnivorous, he is capable of subsisting on animal food only, or on vegetables only;

in short, he is qualified to live in every variety of climate, soil, and situation.

The length, diameter, and structure of the coats of the *alimentary canal*, and the manner in which the different parts of that canal communicate with one another, which is more or less favourable to the exit or detention of the food, are by no means the same in different animals, and bear a relation to the kind of food. Thus, the alimentary canal of a graminivorous animal is not only much longer, and more complicated in its structure, but also much more capacious than that of a carnivorous animal, whose food contains more nourishment in smaller compass, and is more readily digested.

The alimentary canal of an animal designed to live partly on vegetable and partly on animal food, holds a middle place between that of a carnivorous and graminivorous animal. In this class Man is included; and, when the individual reaches to maturity, the alimentary canal is generally between thirty and thirty-six feet long.

In some of the lower animals, no alimentary canal is found, as in the tape-worm that infests the human intestines. Their vessels suck in their nourishment, which becomes nutritious in the vessels themselves, as in the vegetable kingdom.

The *round hydatid* is an animal also of a very simple structure: it is probably nourished from without by absorption, and the bag is probably the stomach.

There is still another class of animals which bear a very strong resemblance to vegetables, as to the mode in which they are nourished, which have been therefore called *root-mouthed*, or *rhizostome*. There are apertures in their members, and these lead to tubes which open into a common cavity.

Some animals, as the *Actinia associnia*, consist of little else than a stomach. In other animals, the *alimentary canal* is of a very simple structure, consisting chiefly or solely of a bag, into which the food is received, and of an aperture through which it is discharged. But, in the higher classes of animals, it is more complex in its form and apparatus, being of considerable length, and enlarged in one or more places to constitute a *stomach* or *stomachs*; and in such animals, the term

gullet is applied to the canal which leads into the stomach, and the term *intestine*, to that which leads out from the stomach, and through which the food is conveyed out of the body.

Before the food reaches the stomach, it is minutely divided by the teeth, mixed with the saliva and mucus of the mouth and throat: it is then carried, by means of the muscular power of the gullet, into the stomach, or it is otherwise prepared, before being converted into chyme, within the stomach.

The food, owing to the particular figure, position, and structure of the orifices of the human stomach, is retained within that organ, to undergo the first process of digestion.

Some authors have asserted, that the food is completely digested within the stomach, by means of the *gastric juice.* But, in my opinion, this assertion is not well founded, nor do I think the process of digestion complete, even after the aliment has been mixed with the bile, pancreatic juice, and other animal secretions, in its long circuitous route through the intestines.

The *Chyle* or nutritious part, the product of digestion, is afterwards in all probability somewhat changed in its properties during its passage through the lacteal vessels; but it is not completely animalized, until after its admixture with the blood, and until it has been exposed in its passage through the lungs to the influence of the atmospherical air.

The *Human Intestinal Canal* is about six times the length of the body, in order that the food may undergo the necessary changes, and it is divided into two proportions of very unequal size, both of which have their length greatly increased by various convolutions.

The internal surface of the intestinal canal is much more extensive than the external; the inner coats being folded into doublings, which, performing in some measure the office of *valves*, have been named by anatomists *valvulæ conniventes;* and the inner surface is still further extended by the subdivisions of these valvulæ into very small villi.

By the above means, the internal surface of the intestines is much extended: more space is given for the absorption of the nutritious part of the aliment, and the addition of those

secreted fluids which probably have a chemical effect upon our food, and also for the addition of the mucus which defends the intestines from the acrimony of its contents.

The food is carried through this long and circuitous route by a series of powerful muscular fibres, which constitute the coats of the alimentary canal; and these coats perform their office so completely as to propel the contents of the intestines contrary to their gravity, and even to push forward air or quicksilver.

To this effect the muscles of the parietes of the belly, and that muscle between the belly and chest called Diaphragm, essentially contribute.

The muscular coats also produce the peristaltic and anti-peristaltic motion, which is kept up by the stimulus of the food. Thus the various contents of the alimentary canal are intimately united; some are dissolved; others enter into new combinations: thus also the alimentary mass is presented to the lacteal vessels, which take their origin from the inner surface of the intestines; and the discharge of that part of our food which is useless is accomplished. But as, without the addition of some other covering, the muscular coats of the alimentary canal would be exposed to be torn; therefore the membrane called Peritonæum, which fixes the alimentary canal to the back-bone, is continued over the stomach and intestines, forming their external covering, by means of which the alimentary canal is enabled to resist over-distention from air or fæces.

There is still another property, which is indispensably necessary to the alimentary canal, viz. a power of accommodating its capacity to the quantity of its contents. This is provided for by the elasticity and expansive power of all the coats, owing to the introduction of a quantity of loose cellular substance between the muscular and villous coats, and also to the loose manner in which the stomach and intestines are fixed to the body.

Lest the alimentary canal should be injured by the acrimony of its contents, and in order to facilitate the passage of these, the innermost coat, called, from its resemblance to velvet, *villous*,

is moistened and besmeared by a considerable quantity of a mucous fluid, which is derived from a number of glands, imbedded in the cellular substance uniting the muscular and villous coats, and which is well calculated for defending the villous coat of the intestines from the acrimony of its contents; and also by a liquor secreted by the small arteries upon the villous coat, called the *Liquor Entericus.*

CHAP. II.

OF THE PARTICULAR ORGANS BY WHICH THE FOOD IS PREPARED BEFORE IT PASSES INTO THE STOMACH.

IN order that the food may undergo the necessary preparatory changes, it is received into the mouth, which, in the more perfect animals, consists, in front, of the lips; above, of of the hard palate; of the soft palate behind; laterally, of the cheeks; and below, of the tongue. The food of many animals is immediately subjected to the process of mastication; such animals, therefore, are provided with a moveable under jaw, in which teeth are implanted, as well as in the upper jaw.

The movements of the jaw, and structure of the teeth, merit peculiar attention, as being an index to the kind of food. If the under jaw be so constructed as to admit only of a vertical motion, we may infer, that that animal lives chiefly, or solely, on animal food; but if, on the other hand, it admits both of the vertical and horizontal movement, the presumption is, that the food is of a vegetable nature: and between these extremes, as in the human body, there are intermediate gradations, enabling certain animals to live both on vegetable and animal substances.

The form, number, and size, of the teeth correspond exact-

ly with the form of the under jaw, and kind of motion of which it is susceptible.

For the purpose of mastication, animals are provided with teeth, and the life of the animal depends upon the teeth: when the fore-teeth are gone, a graminivorous animal cannot crop the grass, and is deprived of its means of subsistence; but man may live after his teeth are gone, for the deficiency of teeth can, to a certain extent, be supplied by art.

The form of the teeth of carnivorous and graminivorous animals is widely different. The former are of a conical shape, and act like scissors; but the teeth of the latter are broad and slightly grooved on their surfaces, and are well adapted for triturating vegetable substances.

The teeth of carnivorous animals do not suffer from attrition so much as those of graminivorous animals: hence the former are only encrusted by a hard coating called *enamel*, whereas the enamel winds through the substance of the teeth of the graminivorous animal, which are much more exposed to attrition.

There are some animals, as the elephant, hippopotamus, and walrus, which, besides having teeth for masticating their food, are provided with large canine teeth, which may be considered as weapons of offence; and the large canine teeth of the lion, tiger, dog, &c. assist them in catching and dividing their prey.

The tongue and cheeks are so constructed as to prevent any part of the food from escaping from the teeth; the former is admirably constructed for ascertaining when the food has undergone the necessary degree of mastication, and by its flexibility the bolus of food may be turned over and over in every direction.

The food of some animals undergoes a preparatory change within a large sac, or first stomach, and is returned from the first stomach and is again chewed. Some of the carnivorous animals, on the other hand, either only chew their food once, or not at all, as fishes and serpents; the latter swallow their food without chewing it. According to some travellers, when a serpent wishes to devour any animal which is too

large for it to swallow, it twines itself around it, breaks its bones, and besmears it with a glutinous matter.

Animal food seems to need comminution less than vegetables, for all animals which live on vegetables have an apparatus to reduce it into small pieces. Granivorous animals have two cavities, each of which contain food; the one may be compared to the grinding stones, the other to the hopper.

The gizzard of fowls is a powerful instrument of trituration; it has been found to break glass; to break lancets, without being injured; to flatten a tube, which, according to Reaumur, required a pressure of 400 lb.; but as the gizzard made the pressure as well as the resistance, the pressure was equal to 800 lb. The internal coat of the gizzard is not only callous, but the motion of it is so exceedingly slow and uniform, that it cannot be seen on opening the belly of the animal. This stomach acts in all directions, and grinds the food. Small stones are generally found in the gizzard, mixed with the food; these are supposed to be swallowed in order to grind the food. Spallanzani, however, supposes that they are swallowed by chance, and for no purpose, as digestion goes on without them; but Dr Fordyce and Mr Hunter suppose that it takes a longer time to comminute the food, unless these stones are swallowed. Carnivorous birds are not known to swallow these stones, but domestic fowls always select them. Dr Fordyce found, that chickens hatched artificially by heat, did not digest their food properly unless they got pebbles: These stones are therefore purposely swallowed to assist the gizzard in the trituration of the food.

Some fishes have a stomach somewhat resembling the gizzard, which is surrounded by strong muscles, but not callous on its internal surface. Fishes also swallow stones, and, by the assistance of these, they break down shell-fishes. Birds, which feed both on grain and animal food, have a sort of intermediate structure in their stomachs.

The food is intimately mixed with the saliva, which is secreted by three large glands, and by a number of small glands, situated on the inner side of the mouth. The saliva was supposed a ferment, which favours the decomposition of the ali-

ment. Dr Macbride entertained this idea, and he found that air-bubbles arise sooner from aliment mixed with saliva than with pure water; hence shewing it was a ferment. But Dr Fordyce remarks, that this argument is inconclusive, because saliva being viscid, prevents the extrication of air-bubbles which arise, but which water allows to escape.

Besides comminution and mixture with saliva, it is probable that food undergoes changes in certain reservoirs, which are proper to ruminating animals, and which contain the food before digestion. That kind of food which is easily digested, passes at once into the fourth stomach. This happens with the milk which these animals when young consume; whereas the fibrous and more indigestible parts, undergo a preparatory change within the first stomach, from which sometimes so much gas is extricated as to prove fatal: from this first stomach it is again brought up and chewed, and then it passes to the second, then to the third and fourth stomachs, remaining a longer or shorter time in each. It is probable that some change, besides mere maceration, takes place in the three uppermost stomachs, for in the second and third stomachs the food will not be further affected by maceration.

It has been supposed by some authors that the pouches connected with the throats of some of the *simiæ* and of the *marmot*, are reservoirs in which the food is accumulated.

It is probable that some change takes place within the crop of birds. Pigeons and eagles are provided with a crop, which is perhaps a reservoir in which the food is collected, and which is capable of holding between twenty and thirty ounces, whereas the digesting stomach is capable of holding only two or three ounces. The large end of the stomach of every animal serves the purpose of a reservoir, for when the dog is opened, the food in the large extremity has been found less digested, than nearer to the pylorus. The art of cookery, even to unpampered stomachs, renders our food more digestible. The heat in the cooking coagulates more or less the different fluids; besides this, it seems to produce a more intimate union between its different parts.

OF THE TEETH.

All the *mammalia* have teeth excepting some species of whales, Scaly Lizards, and the American Ant-eaters. The teeth of different animals vary much in form, size and number. Some animals, as the ox and sheep, have teeth only in the under jaw. Others, as the Mammoth and Elephant, have only two grinding teeth in each jaw; these are in constant use, but they are provided with a succession of teeth; and in some animals, as the lobster, the teeth are placed within the stomach.

The teeth of fishes are very numerous; they are fixed in the jaws, palate, back-part of the partition of the nose, and beginning of the gullet.

The human teeth are not only useful as instruments of manducation, but also assist us in pronouncing certain letters of the alphabet.

There are some national peculiarities as to the teeth. The greater size and oblique position of the teeth of the Negro have been already noticed. BLUMENBACH has stated, that the incisor teeth of some Egyptian mummies resembled truncated cones; and also, that the canine teeth were broad and flat on the masticating surfaces; a circumstance also noticed by MIDDLETON, in a mummy preserved in the University of Cambridge.

This alteration in the form of the teeth may probably be imputed to the teeth having been worn down. I have two Esquimaux skulls, in which the teeth have been worn down to a great degree, and are of the same form which BLUMENBACH has described.

Before proceeding to describe in detail the nature of the human teeth, it is necessary to premise a brief description of the *gum*.

The gum is a red coloured substance, which adheres firmly to the alveolar processes, and to the necks of the teeth. Before the teeth are cut, the gum, which has somewhat of a cartilaginous hardness, and which forms a ridge over the whole length of the jaws, is a sort of substitute for the teeth. The

gum covers the transverse partitions between the teeth, and is fixed to the sides of the necks of the teeth; and hence, when the gum is destroyed, the teeth seem larger. The gum possesses a certain degree of elasticity, and retracts when divided.

The gum possesses in its healthy state but little sensibility; but when much stretched and inflamed, as during dentition, it causes exquisite pain, convulsions, and even death. The use of the gum, is to fix the teeth more firmly in the jaws. In the adult, there are sixteen teeth in each jaw; in all thirty-two; but sometimes only twenty-eight or thirty.

The teeth of the upper jaw are placed nearly perpendicularly in respect to the skull, whereas those of the under jaw incline a little inwards. The human teeth resemble those of a carnivorous and graminivorous animal.

The periosteum only covers the roots of the teeth, otherwise it must have been liable to be bruised during manducation.

Each tooth consists of a body, and of one or more roots; and between these there is a contracted portion, which has been called the neck or collar of the tooth.

The roots of the teeth are implanted within the alveolar processes of the jaws which are spongy bones, in the same manner as a nail is inserted into a piece of wood; or they are fixed into the jaw by what anatomists call *gomphosis*.

The sponginess of the jaw prevents the teeth from being readily broken during manducation. The roots of the teeth are fixed to the alveolar processes by the periosteum, which lines the sockets, and is reflected upon the roots of the teeth, as far as the collar of the tooth, where it is attached to the gums, which covers the alveolar processes, and is perforated by the teeth.

The length of the roots of different teeth is various; those of the dog-teeth are the longest in the human body, and next to them those of the front teeth of the upper jaw.

The roots of the grinding teeth are the shortest, and diverge at a considerable angle from the body of the tooth. The smaller grinders of the upper jaw have three roots. The larger four; but these, from the vicinity of the antrum maxil-

lare, are necessarily shorter than those of the under jaw. The roots are somewhat of a conical figure : thus the pressure falls upon the sides, and not upon the apex of the bone, where the bloodvessels and nerves enter the tooth.

The roots of the grinding teeth diverge from each other: hence the body of these teeth is supported in part by the alveolar process, and the pressure divided during manducation.

The neck or collar is grasped by the socket, and also by the gum; and when this has been destroyed by scurvy, salivation, or other causes, the teeth frequently fall out.

That part of the teeth above the gum, is covered by a very smooth, hard, white, and insensible substance, in texture and appearance like porcellanous shells, called *Enamel*, which becomes gradually thinner towards the neck of the tooth ; or that part of the tooth which is exposed to the greatest degree of attrition, has the thickest coating of enamel. Many savage nations have brown or black teeth, from their custom of chewing Areka nut or Betel nut ; and, according to Mr Marsden, to do this the more effectually, they abrade the enamel, that the tooth may more perfectly receive the empyreumatic oil of the coco-nut shell. The enamel is not of an uniform thickness in different teeth, nor in every part of the same tooth. It is thicker towards the upper surface than in other parts of the tooth, where the teeth touch and rub on each other during mastication.

The fibres of the enamel are very small, parallel to each other, and perpendicular to the surface of the tooth, not only on the flat part of the tooth, but also on the sides of the base. By such an arrangement of the fibres of the enamel, it is not apt to scale off; and therefore is well calculated to resist attrition. The enamel is sometimes deposited irregularly on the surface of the teeth, owing to irregularities in the bony parts of the teeth over which it is deposited. The enamel of the teeth is not an organised substance ; it has not its proper bloodvessels ; and was not tinged of a red colour, by giving an animal madder; though the bony part of the teeth, and all the other bones of the animal, had acquired a deep crimson colour.

The enamel contains, according to the experiments of Mr Pepys, 78 *parts of phosphate of lime, and* 6 *of carbonate of lime, in the* 100. It is almost entirely soluble in acids; and retains its white colour, though exposed to a considerable degree of heat. The enamel forms only a crust for the teeth in man, and carnivorous animals; but, in the ruminant animals, it dips into the body of the tooth, and, being much harder than the osseous part, it is not so quickly worn down; and, therefore, the tooth is always kept sharp, and fit for use.

The enamel of the teeth of old people is generally worn off from long-continued attrition; after which, the bony part of the tooth is more rapidly destroyed; the surface of the tooth, therefore, appears concave.

On exposing the section of a tooth to heat, the thickness and extent of the enamel are very conspicuous, the bony matter assuming a black or dark-brown colour, whilst the enamel retains its white colour. The enamel is seen passing farther down on the outer than on the inner part of the teeth.

The roots of the teeth are covered by a thin layer of yellow matter, which has been called *horny substance.*

Every tooth has a smooth, small, internal cavity, of the same shape as the body of the tooth, which is filled by a substance called Pulp; and if there be two or three roots, there are corresponding openings leading from the pulp of the tooth into the canals, each of which leads to each root. There is a small aperture near the point of each root, which leads into the cavity of the tooth, through which the bloodvessels and nerves enter into the substance of the tooth.

The bony * matter of the teeth, which is more compact and harder than that of most other bones, consists of a number of layers, parallel to the pulp, and to each other; and, according to Mr Pepys, consists of 58 parts in the 100 of phosphate

* Eysson, (Tractatus Anatomico-Medicus de Ossibus Infantum, p. 188.), and Cuvier, (Leçons d'Anat. Compar. tom. iii.) affirm, that the bony part of the tooth differs from common bone in its structure and manner of formation; and that it resembles common bone only in hardness, and in its constituent ingredients.

of lime, and of 4 of carbonate of lime, of jelly 28; and the water of composition and loss, amounted to 10 *. This bony part differs from other bone in not being cellular.

According to Berzelius, the osseous substance of the teeth consists of,

Phosphate of lime,	61.95
Fluate of lime,	2.10
Carbonate of lime,	5.50
Phosphate of magnesia,	1.05
Soda, with a little muriate of soda,	1.40
Gelatine, water, &c.,	28.00
	100†

The bony part of the teeth is much more incorruptible than common bone. I have seen human teeth quite entire, which had lain in the ground for 500 years, whilst the other bones had crumbled down into dust.

Teeth also are not affected by rickets; they are not, like the other bones, rendered soft by that disease.

The teeth are amply furnished with *bloodvessels*, which may be filled with a colouring liquor, and, if divided, pour out blood, as the teeth are sawn across by the dentist.

As a further proof of the vascularity of the teeth, Nodes sometimes form on them; and the roots are sometimes joined together by Anchylosis.

The teeth have also *Lymphatic Vessels.*

Though the *Lymphatic Vessels* of the teeth cannot be demonstrated, there are various facts which prove their existence, viz. the absorption of the roots of the first set of teeth, the colour given to the osseous part of the teeth by madder being removed after discontinuing the use of it, and the swelling of the lymphatic glands from a carious tooth.

This fact is still farther proved by the changes which the teeth undergo during the lifetime of the animal, which are very remarkable in the elephant.

* Vide Fox on the Teeth.

† Vide Nicholson's Journal, vol. xviii. p. 75.

The great sensibility of the teeth proves that they have *nerves*. *The nerves* enter the roots of the teeth, and may be traced into their bony canals; and, in proportion to the bulk of the teeth, are larger than in almost any other organ of the body *.

The *nerves* of the teeth in the under jaw are derived from the inferior maxillary nerve. Where that nerve enters the under jaw, it is much larger than where it passes out at the anterior mental foramen; as, during that course, the nerves of the teeth are sent off from it; and these nerves may be traced through the osseous canals of the teeth. The *nerves* of the teeth of the upper jaw are derived chiefly from the second part of the fifth pair of nerves; and those of the under jaw from the third part of the fifth pair.

The teeth of animals, during the progress of life, are much exposed to attrition, and also to various accidents. Animals, therefore, are provided with a succession of teeth. Man is provided with two sets of teeth: some individuals have had three sets.

Of the Teeth in the Adult.

The teeth, when viewed in conjunction, form a parabola, or in some cases an ellipse: the line formed by the teeth is not straight; the front and back teeth of the lower jaw are rather higher than those in the middle, in order to meet the teeth of the upper jaw. The teeth differ much in form; and, in different nations, most materially in size, being much larger and longer in the Negro than the European. The largest teeth I have seen are in those of the skulls of the natives of Van Dieman's Land. The teeth were formerly divided into three classes, the *Incisores*, *Canini*, and *Molares*. The molares have been divided by J. Hunter, and more modern anatomists, into two classes, the *Bicuspidati* and *Molares*. The incisores of the upper jaw pass over those of the under jaw; and, owing to their oblique situation, act like scissars in dividing the food. The canine, or *Laniarii* of Linnæus, on

* Vide Monro on the Nervous System.

account of their strength and thickness, are well constructed for perforating and tearing animal substances.

The four fore-teeth in each jaw have been named *Incisores*, as they cut the aliment. These teeth have broad flat bodies, which are convex before and concave behind, and have a sharp cutting edge at their base, by their foreside turning inwards, while they are sloped down and hollowed behind. The middle incisores are by much the largest, and those of the upper are larger than those of the under jaw. When the stamina of two sets are formed, each has its own socket; those nearest the edge of the gums being placed more forwards, and the others lodged farther back within the jaw-bones.

The *Cuspidati*, or *Canine* teeth have been named from their likeness to the teeth of the dog. They are broader, longer, and stronger than the incisores. Their bases are formed into a sharp edge, as the *Incisores* are; only, the edge rises into a point in the middle. Each of them has generally but one long root, though sometimes they have two. The roots are crooked towards the end. The *Canini* of the upper jaw are larger and longer, and have more crooked roots, than those of the under jaw. The form of their base is fit both for piercing and cutting; and the long crooked root of each makes it secure in the socket.

There are five *Dentes molares*, or *Grinders*, in each side of each jaw; in all twenty. Their bases are broader, more scabrous, and with a thinner cortical substance than the other teeth. They have also more roots; and, as these roots generally divaricate from each other, the partitions of the sockets between them bear a large share of the great pressure they suffer. The human grinding teeth differ most materially from those of the inferior animals: they have not flat surfaces, with prominent ridges, part of which is composed of enamel; but there are prominences of an obtuse form, arising from the surfaces of these teeth, which are incrusted by enamel *. The base of the first grinder has an edge pointed in the middle, on its outside, resembling the *Canini*; from which

* The enamel is equal in thickness all around these teeth.

it slopes inwards, till it rises again into a point. It has generally but one root, which sometimes is long and crooked at its point.

The second *Dens molaris* has two points on its base, rising almost equally on its outside and inside. It has two roots, either separate or run together, but shorter than the root of the first. These two anterior grinders are much smaller than the three that are placed farther back in the mouth. The third and fourth are very broad in their bases, with four or five points standing out; and they have three or more roots.

The fifth, commonly called *Dens sapientiæ*, from its coming through the gums later than the other grinders, has four points on its base, which is not so large as the base of the third and fourth, and its roots are less numerous. Its body is somewhat rounder, and is smaller in the upper than in the lower jaw, so as to be directly opposite to it.

The *Incisores* of the upper jaw are broader than those of the lower jaw; hence the superior grinders are placed farther back than the lower ones, so that, when they are brought together, by shutting the mouth, the points of the grinders of the one jaw enter into the depressions of the opposite grinders; and they are all equally applied to each other, notwithstanding the inequality of their surfaces.

From the numerous roots of the *Dentes Molares*, the lateral pressure in grinding does not render them loose; and, as the sockets in the upper jaw are more spongy, and the teeth are more liable, by their situation, to fall out *, the grinders there have more numerous and more separated roots than in the lower jaw †. The number, however, of the roots of the teeth of both jaws is very uncertain. Sometimes there are more, sometimes fewer. Frequently the roots are joined together; at other times they are all distinct. The disposition of such as are distinct is also various; for, in some, the roots stand out straight; in others they separate; and in others, again, they are crooked inwards. When the roots are united, we can still

* Galen. de Ossib. cap. v.

† Fauchard, Chirurg. Dent. chap. I.

distinguish them, by remarking the number of small holes at their points, which determine the number of roots each tooth ought to be reckoned to have *.

Of the Formation of the First Set of Teeth.

The teeth are formed upon *pulps*, which are contained within the alveolar processes of the jaw. Upon examining the fœtus in utero, about the fourth or fifth month after conception, we find that the alveolar processes are not completely formed. There is a *large canal in the jaw*, which, at different places, is impressed by membranous bags, called *The Capsules of the Teeth*, which contain the pulps and rudiments of the bodies of these organs. Even at this very early period, this canal is not of a very uniform breadth. It is adapted to the teeth, and therefore considerably broader at the back than at the fore part. In the bottom of this groove, the internal maxillary bloodvessels and nerves are disposed, which afterwards are lodged in a distinct canal. In a short time, there are a *number of ridges which extend from the bottom and inner sides of this canal*, and which form sockets for the teeth. These sockets extend very quickly, and contract at their upper parts; so that, at the time of birth, there is found only beneath the gum a small transverse fissure. In consequence of this structure, the teeth within the jaw are not injured while the child is sucking.

The alveolar processes of the grinding teeth are situated immediately before the tuberosities of the upper jaw, and the coronoid processes of the under jaw.

The pulps of the teeth are involved in capsules, which consist of two membranes, in both of which there is a great number of bloodvessels. The external membrane adheres to the gum, and the internal to the basis of the pulp.

The pulps of the teeth are at first of a gelatinous consistence, nearly of the figure of the tooth, and adhere to the inner surfaces of the gums. The pulp of each tooth is contained in its proper capsule, which is shaped like the tooth,

* The above is the description of the teeth by Dr Monro primus.

but without roots; which capsule is attached, by means of its nerves and bloodvessels, to the bottom of the alveolar processes; and its upper part is attached to the inner side of the gums. The pulp becomes gradually firmer and larger, so that at length it acquires the shape and size of the tooth about to be formed upon it.

The *Ossification* begins about the sixth month after conception, upon the pulps, in the form of spots; the situation of which corresponds with the grinding surfaces of the molares and cutting edges of the incisores. The number of these ossifications corresponds with the eminences on the pulp; these gradually increase, and *form a thin shell of bone*, which covers the surface of the tooth. In the incisor teeth, there are generally three points of ossification; in the canine only one point; and in the molares four or five points of ossification; and these increase, in some, until their bases are united. The ossification in the basis takes place *in a lamellated manner, and from without inwards.* The bony shells which form the teeth are a little contracted at the collar of the tooth; and in proportion as the bony part of the tooth becomes thicker, the pulp diminishes in some. The sides of the alveolar processes gradually become higher as the root of the tooth grows, and continue in contact with the neck of the tooth.

At the period of birth, the outer shells of five teeth are found on each side of each jaw, or of twenty teeth. The bodies of the teeth are first converted into bone; and the ossification goes on by a successive deposition from without inwards; the layer next the enamel being first formed, and the other layers being added within it. When the ossification of the body of the tooth has been completed, the pulp is compressed; for it has no process originally corresponding with the roots. The roots are then added to the teeth, and are formed upon the pulp, which is elongated, in consequence of the pressure made upon it by the progress of the body of the tooth. When there are two or more roots, the osseous fibres extend across the under part of the bodies of the teeth, and leave vacant spaces, through which the processes of the pulp are protruded, and upon which the roots are formed. By the

addition of roots to the teeth, the tooth cuts the gum, but the tooth is not complete when it appears through the gum.

Of the Formation of the Enamel.

The enamel is secreted by the outer membrane of the capsule of the pulp, and is deposited, under the guidance of a membranous case, when the ossification of the body of the tooth has been in part completed. *The enamel*, when first formed, is so soft that it may be scraped by the nail, and seems, in the tooth of the elephant, to consist of small crystals. *The enamel* is at first perfect on the cutting edges, or protuberances, of the tooth; and it does not extend beyond the neck of the tooth. *The enamel* continues to be secreted, as long as the teeth are contained in their capsules. The membrane which secretes *the enamel is but of temporary duration: after having performed its office it disappears.* The teeth, by becoming larger within their sockets, stretch, and at length burst their capsules, which are removed by absorption. The gum is also removed, and the tooth appears through it: hence all that portion of membrane which loosely surrounded the body of the tooth is destroyed, when the tooth has risen to its proper height. The bony part of the tooth, however, continues to grow after the teeth have cut the gum: about one-third of the length of the root is added, by which the tooth is elevated, and cuts the gum.

The enamel gives a partial covering only to the teeth of some animals, as the *glires*. It covers only the anterior surfaces of the teeth of these animals: hence, as the osseous parts of the teeth are softer than the enamel, it wears down faster, and therefore the teeth are always sharp, and fit for use. But in the grinding teeth of animals that live on vegetable matter chiefly, as in those of the horse, elephant and ox, the several plates of enamel pass down from the crown to the bottom of the tooth, between the bony substance of the tooth, in a winding direction; and, besides, there is in the body of the tooth another substance, which unites the layers of the tooth, which was discovered and fully described by my pupil Dr Blake, under the name *Crusta Petrosa*, which is deposited by the same capsule as the enamel.

It is remarkable, that the teeth of some graminivorous animals are sooner worn down than those of others. Those of sheep last but for seven or eight years; those of the ox for twenty years; those of a horse for thirty or forty years; and those of the elephant for nearly a century. This latter animal is, during his whole life, provided with a constant succession of teeth *, through which the hard enamel winds, serving to render the teeth more durable; and owing to its superiority in hardness to that of the bony part, rendering them, at the same time, more fit for mastication. Mr Corse, who discovered the above remarkable fact as to the structure of the elephant's teeth †, many years ago was so polite as to send me a full account of his discovery: and, to make use of his own words, "That I did not, in my paper to the Royal Society, alter my opinion, in consequence of any communication with Dr Blake, or Mr (now Sir Everard) Home, the following extract of my letter to Mr Fairlie will shew."

"My Dear Sir, *Tipperah, Nov.* 17. 1795.

"I have this day dispatched the two heads of elephants.—The structure of the grinders is very curious, being *composed* of a number of perpendicular strata, covered with a strong enamel, and each stratum is joined to another, by the *common bony matter*, which being softer than the enamel, wears away faster by the mastication of the food, leaving the enamelled parts considerably higher, so that each tooth soon assumes a ribbed appearance, as if originally formed with ridges.

"What I have now mentioned will appear very evident, from a slight inspection of the grinders in the lower jaw of the mooknah, where each of the posterior, or second teeth, had

* Each of the milk grinders, which cuts the gum about ten days after birth, consists of four perpendicular teeth or laminæ, covered by enamel. These laminæ are united only by membranes and soft parts, when first joined, and contained within the bony canal within the jaws; and they are joined by bony matter before the tooth cuts the gum. As the anterior laminæ are worn down, others are added from behind. The second set consists of eight or nine laminæ; the third set of twelve or thirteen, and so on, to the eighth set, when each grinder is made up of twenty-three laminæ.

† Vide Phil. Trans. 1799.

just cut the gum so much, as to be used a little before the animal's death, whereas, the after-teeth in the upper jaw remained wholly within the gum."

The teeth of the ox and horse do not appear in succession like those of the elephant; but there is another provision, by which the animal is supplied with teeth during the whole of his life. The body of the horse's tooth is equal in length to the breadth of the jaw; and as the upper surface of the tooth is worn down, the roots are added, in consequence of which the tooth rises in the jaw. The wearing down of the horse's teeth is well known to jockeys: thus they judge of a horse's age; for between the seventh and eighth year the cavity in the middle of the incisor teeth, which is filled by a blackish tartar, is no longer visible, in consequence of the teeth having been worn down.

Of the Period at which the First Set of Teeth, or Temporary Teeth, appears.

There is the utmost variety as to the time at which the teeth appear.

In a stout, healthy child, the incisor teeth of the under jaw show themselves between the sixth and seventh month after birth; but, in a puny, sickly child, not until the child is perhaps a year old.

There are some diseases which seem to have a specific effect in arresting the growth of the teeth.

I have repeatedly observed, that children labouring under rickets, or the chronic form of the disease called *water in the head*, do not get their teeth till they are two or three years old.

The larger incisors of the under jaw first cut the gum.

A few weeks after the central incisors of the under jaw have cut the gum, those of the upper show themselves, and, in the next place, the lateral incisors of both jaws. When the child is about a year and a half old, the smaller grinders of the lower jaw cut the gum; these are followed by the smaller corresponding grinders of the upper jaw.

In the fœtal jaw, the smaller incisor, and the smaller grind-

ing teeth, are in contact; the canine are lodged deeper in the jaw. About the twentieth month, the canine teeth show themselves: in the first place those of the under jaw, and soon after those of the upper jaw.

The Caninus appears after the first molares, or about the sixteenth or twentieth month; as it is out of the line, and, till the jaw extends, there is not room for it; and the jaw at this place grows in a greater proportion than at any other part.

The posterior or larger molares appear between the twenty-fifth and thirtieth month.

It may not be improper to add, that there is a great irregularity as to the time the teeth are cut.

Of the Shedding of the First Set of Teeth, and of the appearance of the Second Set.

As there is the utmost variety with regard to the time at which the teeth appear, so there is very great variety respecting the time at which teeth are shed. In a child at birth, the rudiments of the first and second sets are found within the jaw; the basis of the second set are formed long before they first cut the gum.

Whilst the first are receiving roots, and cutting the gum, the second set is dormant, and continues so, long after the first have appeared.

About the sixth year, all the second set, excepting the wisdom teeth, are ossified; so that, at this period, there *are no less than forty-eight teeth in the jaws:* the first set, consisting of twenty, have appeared; and the second set, consisting of twenty-eight, lie within the jaws.

The sixth tooth, or first large molaris of the adult, is also dormant.

The first set of teeth fall out, in consequence *of their roots being absorbed*, which absorption takes place in consequence of the enlargement of the second set; by which, pressure is made on the bony partitions between the sockets of the first and second set of teeth, and also on the roots of the first set of teeth; which leads to the absorption of the bony partitions, as well as of the roots of the first set.

In consequence of the above changes, the second set comes forwards, and replaces the first; but they are contained in their original sockets.

The first set generally begin to fall out when the child is about six or seven years old.

The anterior molares of the second set generally appear first; then the larger incisors of the lower jaw; in a month or two, the larger incisors of the upper jaw; then the molares of the child become loose, to make way for the smaller molares of the second set: the canine generally follow some time after; and, last of all, the larger molares.

The shedding of the first set is generally not completed in less than six years; and, in some instances, some of the first set of teeth remain in the jaws during the greater part of life.

Of the Formation of the Second Set of Teeth.

The second set, like the first, is formed upon *pulps, and these pulps are parts or elongations* of the *pulps* of the first set, which are sent out as soon as the rudiments of the first have made some progress.

The pulps of the second set of teeth *are originally within the same socket, and adhere to the capsules of the first set;* and these capsules are so intimately connected, that it is impossible to separate the one from the other, without lacerating one or both. By degrees little niches are formed in the internal alveolar plate, which gradually form a *distinct socket around these sacs for the second set of teeth.*

Dr Blake, who, I believe, discovered the connexion between the sacs of the first and second sets, has very fully explained the above mentioned facts in the following passage.

"As the sacs of the permanent teeth advance, the sockets of the temporary ones become enlarged, and little niches are formed in the internal plate of the alveolar processes, answering to each socket, which are situated rather laterally; that is to say, at a greater distance from the symphysis, or centre of the jaw, than the centre of each respective temporary socket.

"These niches do not penetrate so deep as to the bottom

of the temporary sockets, but increase in proportion with the size of the permanent sacs, and gradually form a distinct socket round each of them.

"There is, however, an opening left immediately under the gum, through which the membranes of both sets of teeth continue to be connected."

The second set of teeth come forwards under the first set.

The wisdom teeth begin to be formed about the eighth or ninth year, but do not appear until the twentieth or twenty-first year; or sometimes until a later period of life.

The teeth fill the jaws, by which the principal grinders are near to the condyles of the jaw, both for the sake of strength, and also that every part of the food may be manducated.

Two sets are given, not merely as they last longer, but also to fill the jaw in its enlarged state; for the teeth could not grow like the soft bone.

Before concluding this section, it may not be improper to call the attention of the reader to the very different sizes of the alveolar processes and teeth in different nations.

Changes in the Teeth and Jaws in advanced Life.

In consequence of the continued attrition of the surfaces of the teeth during manducation, the opposed surfaces are worn down, by which the form of the teeth is materially altered.

The teeth, in persons far advanced in life, are much worn down; the enamel is worn off the bases of the incisor and canine teeth in the first place; and the bony part of the teeth continues to live. After the points, and a considerable share of the bony part of the tooth is worn down, the tooth appears concave, owing to the greater hardness of the enamel. The outer crust of enamel being sharp, assists very much in dividing our food. In progress of time, the teeth are completely worn down to their necks; and in proportion as the surface is worn down, the cavity of the tooth is filled up by a newly formed substance, otherwise its cavity must have been exposed. The newly formed substance is more transparent than the rest of the tooth, and is obvious in the middle of the tooth.

The molares of persons advanced in life are generally shed before the incisors, showing what kind of food is fittest for the old.

OF THE VARIETY OF THE JAW AT DIFFERENT PERIODS OF LIFE.

There is, perhaps, no bone in the human body which, during the progress of life, undergoes a greater alteration in its figure than the under jaw-bone. These changes in the shape of the jaw are in a great measure owing to the teeth.

Before the appearance of the teeth, the jaws are *proportionally shorter* than in animals fully grown, which has a considerable effect on the Facial Line.

The jaws in an infant are not only shorter, but also not so deep as in the adult.

It has been stated, that in a child at birth the depth of the jaw is about the seventh part of that of the head; at the age of thirty, it measures somewhat less than the fifth part. As the teeth advance, the posterior angle of the jaw is pushed back, and becomes more nearly a right angle; and the posterior part of the rising branch, which was at first very oblique, becomes straight.

From what has been said respecting the teeth, it is obvious, that, as the incisor teeth and grinding teeth of the child are at first in immediate contact, the jaw must grow rapidly in order to make room for the eye-teeth; and, as the grinding teeth of the second set are more numerous than those of the first, the jaws must extend very much between the coronoid process and the grinders of the first set, to make way for the grinders of the second set; hence we find, that the jaws are in a constant state of growth until the twentieth year, in order to make room for the addition of the wisdom teeth.

When the teeth fall out, the alveolar processes disappear in the upper, as well as in the under jaw. We sometimes observe an osseous net-work which fills up some of the alveolar processes; and the distance between the bony palate and the chin becomes much less.

When the jaws are shut, the under jaw projects considerably beyond the upper. The posterior angle becomes *more*

obtuse, because it is not pushed back by the teeth; and the condyle becomes lower in respect to the coronoid process: hence the anterior part of the under jaw is carried so far forward, and does not meet the upper jaw, excepting at the back of the mouth, where the greatest force can be employed during mastication.

SECTION II.

OF THE SOFT PARTS OF THE MOUTH, AND ITS APPENDAGES.

In a former part of this work, the structure of the upper and under jaws, which form the bony part of the cavity of the mouth, has been explained; and therefore we now proceed to the description of the softer parts, namely, that of the *Lips* and *Cheeks*, which form the fore-part of the mouth and its sides, and the other parts contained within the mouth.

Connected with the mouth, there are muscles for performing the compound motion of the lower jaw; there are glands which secrete mucus and the saliva; and, at the back-part of the mouth, there is a moveable muscular membranaceous arch, which assists in guiding the bolus of food into its passage towards the stomach, and opposes its return through the nostrils.

Within the mouth, there is the tongue, an instrument of speech, the organ of taste, and which also assists in deglutition. A musculo-membranous sac communicates with the posterior part of the mouth, which serves the double office of giving passage to the air into the lungs, and of giving passage to the prepared aliment, before it reaches the gullet; and, at the top of the windpipe, there are muscles which moderate the air in its passage to the lungs, producing different sounds.

Such being the varied purposes of the parts of the mouth, we should at first sight suppose, that the functions of these could not be performed without interfering with each other; and yet there is only one instance of interference, viz. *in sucking and breathing;* and hence the necessity of a passage for air through the nostrils into the lungs, whilst the lips are closely applied to the nipple.

The lips and cheeks, which extend from the cheek-bones, upper jaw, and front of the nose, to cover the teeth, are composed of skin, cellular substance, fat, muscles, glands, and hairs.

In the lips there is a much smaller proportion of fat than in the cheeks; hence these are nearly of the same thickness at all times of life. The fat collected in the cheeks may tend not only to facilitate the movements of the muscles, but also to defend the mucous and salivary glands.

The lips and cheeks are lined by a soft, vascular, mucous membrane, which forms the frœna of the lips; and then, becoming somewhat firmer, forms the gums, by means of which the teeth are secured in their sockets.

A single or a double fissure is not uncommon in the upper lip. The former of these malconformations gives the lip a resemblance to a hare's lip, and the latter to the lip of the *Lion*. This malconformation of the lip is often combined with a fissure in the palate, and even in the mouth.

The cheeks and lips are largely supplied with blood; and, after their bloodvessels have been successfully filled, a number of pointed bodies may be observed on the lips, which project from their surface, and have been called *Villi*. The gums are spongy, and of a red colour, from the quantity of blood they receive.

SECTION III.

OF THE PALATE.

The roof of the mouth has been called Palate. The palate is made up of hard and soft parts. In the erect posture it is placed horizontally. The bony part of the palate consists of the palatine processes of the superior maxillary bones, and of the palate-bones; and these form, in the adult, a bony arch. The membrane of the palate describes, in middle life, a portion of an ellipse; but, in advanced life, the palate, instead of being elliptical, becomes nearly level, in consequence of the loss of the teeth, and the absorption of the alveolar processes which

contained them. The membrane of the palate is marked by transverse lines, and divided longitudinally; which membrane, at different periods of life, varies much as to its thickness, being, in the infant, thick before the teeth appear, and opposing their protrusion; and, in advanced old age, when the teeth have dropped out, it becomes still thicker.

The mouth is bounded behind by a musculo-membranous partition, called *Soft Palate*. It is somewhat of a quadrangular shape, and nearly of an uniform thickness. To the middle of the under-part of the soft palate, a conical-shaped body called *Uvula* is attached, which is of various lengths in different individuals. The point of the uvula is towards the basis of the tongue, and in front of the epiglottis. When this substance is elongated, it creates a tickling in the throat, and sometimes symptoms like those of the chronic inflammation of the chest. A portion of the elongated uvula may be removed by scissars, without risk: the bleeding may be stopped by astringent gargles.

The lateral edges of the palate are subdivided in two musculo-membranous folds, the anterior of which is fixed to the base of the tongue; the other is fixed to the side of the pharynx; and between these folds the *Tonsils* are placed. The muscles imbedded within the arches of the palate, compress the tonsils during deglutition, and press out their contents; and hence the pain in swallowing when the tonsils are inflamed.

The following are the muscles of the palate.

The Petro-Palatinus, or *Levator Palati.*

This muscle arises from the point of the petrous part of the temporal bone, from the cartilage of the Eustachian tube, from which it descends, and is fixed into the middle of the soft palate, and root of the uvula.

It draws the soft palate upwards during deglutition, so as to prevent the food from getting into the nose.

Pterygo-Palatinus, or *Circumflexus Palati.*

This muscle takes its origin from the spinous processes of

the sphenoid bone, behind the foramen ovale, and from the osseous part of the Eustachian tube and the internal pterygoid process: it then sends out a tendon, which revolves around the hook-like process of the internal pterygoid process; and is fixed into the middle of the velum palati, and semilunar edge of the os palati, by means of a broad membrane.

This muscle expands the velum laterally, and also tends to depress it.

Palato-Uvularis, or *Azygos Uvulæ.*

This muscle is enclosed within the membrane of the Uvula.

It arises from the back part of the palate bones, and terminates in the Uvula, which it draws upwards.

Glosso-Palatinus, or *Constrictor Isthmi Faucium.*

This muscle is contained within the anterior arch of the soft palate. It consists of a few thin muscular fibres, which arise from the side of the root of the tongue, and is fixed into the middle of the velum palati. This muscle shuts the opening into the fauces.

Pharyngo-Palatinus, or *Palato-Pharyngeus.*

This muscle is composed of a thin stratum of muscular fibres, which are covered by the membrane of the posterior fold of the soft palate.

This muscle arises from the insertion of the circumflexus palati, and the root of the uvula.

This muscle is fixed into the middle constrictors of the pharynx, and into the upper and back part of the thyroid cartilage.

By these muscular fibres, the velum and uvula are drawn downwards, by which the passage into the nostrils is shut during deglutition; and they also assist in propelling the food into the fauces.

SECTION IV.

OF THE TONSILS.

The tonsils are grey-coloured soft glands, somewhat of an oval shape, and commonly about the size of an almond, with several openings on the surface, leading into cells within the substance of the glands, which are lined by the membrane of the mouth.

In the healthy state, the tonsils secrete a transparent mucus, which assumes a white colour in inflammatory cases, giving the appearance of a slough. An inflammation of the tonsils is accompanied by swelling, which obstructs the breathing and swallowing, and may often be removed, by applying to the inflamed part, (as was recommended by my father), a leech included in a box, in which there is a slit near to its extremity, through which the animal applies its mouth to the inflamed tonsils.

Concretions similar to those in the salivary glands have been sometimes found within the tonsils *.

There are a great number of small mucous glands on the back of the tongue, velum pendulum palati, uvula, and in the vicinity of the tonsils.

SECTION V.

OF THE TONGUE.

The Tongue is not only an organ of taste and speech, but also constitutes a part of the organs of deglutition.

It is firmly supported by the bone called Os Hyoides.

The tongue has been said sometimes to be awanting, and sometimes it is of so large a size as to create indistinct articulation. Trioen has made mention of a case, in which the tongue was " circiter quatuor pollices longa, ore cujus rictum omni modo implet, mento dependeat inferius, eamque argentea theca, oneris causa, adfabre concinnata

* Vide my Morbid Anatomy of the Gullet, Stomach, and Intestines.

fulcire *." I have sometimes seen the tongue adhering to the cheek, which had probably been the consequence of previous inflammation.

In the greater number of quadrupeds the tongue is larger and narrower than in man; is long and flexible, and assists them in seizing their prey, as in the ant-eaters; but in the cetacea it is fixed down to the jaw.

The tongue has been divided by anatomists into three parts, viz. a base, body, and point; and into two surfaces, an upper and under. The tongue is connected by a doubling of the skin called *Frænum Linguæ;* and its sides are fixed to the styloid processes, and to the lower jaw by ligament. The frænum linguæ is sometimes so short, that the child cannot suck well.

There is a line which runs in a longitudinal direction along the tongue; and towards the root of this organ there is an oval-shaped depression, called, after MORGAGNI, *Foramen Cæcum Morgagni.*

The tongue is covered by a cuticle, which forms sheaths for its papillæ, by corpus mucosum and cutis vera. The cuticle of the tongue, in consequence of fever, sometimes attains an unnatural thickness, and after a time comes off in thick flakes.

The papillæ of the tongue, on account of their size, have been arranged *into three classes.*

The *Papillæ Maximæ*, or *Lenticulares*, which are perforated in the middle, occupy the base of the tongue, and are small salivary glands.

The *Papillæ Mediæ*, or *Semi-lenticulares*, which are supported on a small stalk, are scattered over the middle of the upper surface of the tongue.

The *Papillæ Minimæ*, or *Conicæ*, are found chiefly at and near to the point of the tongue.

In herbaceous animals, the tongue is covered by a thick cuticle, which forms a number of papillæ, which are directed

* Vide Obs. Med. Chir. Fascic. p. 142.

backwards, and which prevent their food from getting out of the mouth. The dog and also the cat has a similar apparatus; and the surface of the tongue of the latter has upon it horny villi, which assist the animal in securing its prey. In the dog there is a line of tendon, placed in the upper part of the substance of the tongue, inclosed in a sheath, which extends to the point of the tongue, and which is supposed to assist the animal in lapping its drink. Birds have papillæ not only on the tongue, but also on the palate, to prevent the food from escaping from the mouth.

The tongue in many fishes is covered by a number of teeth, so that it may be doubted whether it be an organ of sense.

The tongue is always kept moist by the mucous follicles, which cover the greater part of its surface, and by the saliva.

The tongue is chiefly composed of muscular fibres, for performing its varied movements; and there is no part of the body which exhibits a more remarkable instance of the variety, force, extent, velocity, and precision of muscular action.

The *Lingualis* * is usually described as a mass of muscular fibres in the substance of the tongue, extending from the base to the point of the tongue, between the hyo-glossus and genio-glossus muscles.

It may be proper to add, that this muscle is by no means well-defined, for its fibres are much involved in the adjacent muscles.

This muscle, which is fixed into the tip of the tongue, raises the tip of the tongue, and brings it backwards.

Hyo-glossus Muscle.

This muscle arises from the base, and one of the cornua of the os hyoides, and terminates in the side of the tongue, near the stylo-glossus. This muscle depresses the edge of the tongue.

Genio-hyoglossus Muscle.

This muscle arises from the symphysis of the under-jaw; and its fibres pass in a radiated manner, to be fixed to the

* There is certainly an impropriety in this term, as the names of the other muscles which move the tongue are of Greek origin.

point, middle, and apex of the tongue, and are intimately mixed with those of the lingualis and hyoglossus muscles. The muscle is also attached to the body of the os hyoides. This muscle raises or depresses the tongue, moves it from one side to another, and draws the tongue forwards, so as to push it out of the mouth; or pushes it backwards, or pulls it downwards.

This muscle also pulls the os hyoides towards the chin.

Stylo-Glossus.

This muscle takes its rise from the styloid process of the temporal bone, and is fixed into the side of the tongue, near to its point.

This muscle draws the tongue to one side, and backwards.

Besides the above muscles, there are a number of short fibres distributed through the substance of the tongue, which have been named and represented by MALPIGHI and DU VERNEY under the names of fibræ longitudinales, transversæ, perpendiculares.

These fibres may serve as auxiliaries to the preceding muscles, or they may act separately; and their action is limited to the particular part of the tongue where they are situated.

The tongue is very largely supplied with blood by the branches of the arteria ranina; hence the greater safety of removing a portion of the tongue by the application of ligature than by the knife, it being difficult to stop the flow of blood. The tongue receives nerves from three different sources. The branches of the fifth pair are distributed upon the point of the tongue; those of the ninth pair of nerves upon the sides of the tongue; and those of the eighth supply the basis.

According to BLUMENBACH, the muscles of the tongue are more irritable than those of the heart, and "appeared to all the bystanders to survive the heart by more than seven minutes, and to retain the oscillations of its fibres altogether for a quarter of an hour; and so vivid were the movements, when I cut across the fore-part of the tongue, that the butcher's

wife compared them to those of an eel in a similar condition, quite in the way that Ovid has compared them to the motions of the tail of a mutilated snake.

"To these observations made upon animals, I may add here a similar one made upon the human tongue itself, the knowledge of which I owe to my excellent friend and much respected colleague, Reimar *."

SECTION VI.

OF THE SALIVARY GLANDS.

These are very numerous, and have been divided into two classes, viz. into the large and small. The larger salivary glands are, the parotid, the submaxillary, and sublingual glands; and are so placed as to be compressed during manducation.

The parotid gland occupies the space between the meatus auditorius externus, mastoid process, and the angle of the lower jaw; and, stretching across the face, in part covers the masseter muscle, becoming much thinner in its substance; and it sends down a process which is in contact with the inferior maxillary gland. The form of this gland is oval; and somewhat flattened before and behind, and lengthened out from above downwards. The parotid gland is covered by the skin, and by some fibres of the platysma myoides, and by a white membrane, which envelops the substance of the gland; and the external carotid artery passes through the substance of the gland, dividing, within it, into three branches; hence the danger of cutting out a portion of this gland. The parotid gland is firmly attached to the neighbouring parts; it is fixed above to the capsular ligament of the under jaw, and to the ascending branch of the under jaw.

Behind, we find the mastoid process; and the sterno-cleido-mastoid muscle, which covers the posterior part of the gland; a litle deeper, the digastric muscle; and, under it, the external carotid artery.

This gland, in the adult, is of a white colour, inclining to

* Edin. Phil. Journ. vol. viii. p. 263.

red. In the fœtus it is much redder, and divided into a number of small parts, which have a soft and delicate texture.

It is in colour and consistence like the parotid.

This is a gland of the conglomerate kind, consisting of a number of distinct lobes, detached from each other, and united by a cellular substance; and each lobe is composed of a great number of small parts, or grains.

It very rarely happens that much fat is connected with this gland.

Around the gland, there are several lymphatic glands, which are frequently swollen from diseases of the neighbouring parts; whereas the salivary glands are rarely swollen.

There is in some subjects an accessory gland, situated close to the external border of the masseter, and along the upper border of the duct of the parotid, which sends out its peculiar ducts, which unite with that of the parotid.

Each lobule of the gland sends out a small duct. These smaller ducts uniting, form the large duct, which, arising from the anterior border of the upper part of this gland, takes a horizontal direction over the anterior part of the masseter muscle, and pierces the buccinator muscle, and the internal membrane of the mouth, opposite to the space between the second and third grinder of the upper jaw.

Morgagni has described the duct, as passing "obliquè antrorsum descendens."

Steno describes it as passing horizontally through the buccinator muscle, obliquely between the fibres of the buccinator.

The diameter of the duct is but small in proportion to its bulk, as the duct has very thick coats.

The canal of the duct is nearly cylindrical, and has two coats. The external is formed of a dense cellular substance, on the inner side of which there is a mucous membrane. There are many branches of the temporal artery distributed upon the parotid gland; and it receives nerves from the portio dura of the seventh pair.

Of the Submaxillary Gland.

This gland is smaller than the parotid, somewhat of an oval

figure, and situated between the inner surface of the angle of the jaw, and the mylo-hyoid and digastric muscle.

This gland is sometimes continued near to the angle of the jaw; and is sometimes connected with the lower end of the parotid.

This gland also joins the sublingual behind the posterior part of the mylo-hyoid muscle.

The duct of this gland, which arises from its upper and fore part, is large, has thin coats, and passes between the mylo-hyoideus and genioglossus muscles, along the under and inner edge of the sublingual gland, and perforates the membrane of the mouth, at the side of the frænum linguæ; and is accompanied by the lingual branch of the inferior maxillary nerve.

The ducts of the salivary glands have sometimes been divided by a cut with a sword, or destroyed by ulceration: the saliva is then constantly discharged, occasioning a salivary fistula. In consequence of obstruction by *salivary concretions*, the duct of the sublingual gland is sometimes so much extended as to form a tumour called *Ranula;* which presses the tongue upwards to the roof of the mouth, creating indistinct articulation, and gives the voice a croaking sound, like that of a frog.

When the ranula attains a very large size, it impedes manducation and deglutition, and sometimes displaces the teeth. When the tumour increases suddenly, the tongue may be forced so far back as to prevent inspiration *.

The ranula sometimes bursts, and discharges a fluid like the white of an egg. The disease cannot be cured, until the cause of the obstruction be removed, by cutting into the tumour.

Scirrhus of the salivary glands is by no means of rare occurrence; and but rarely leads to cancer.

* A case occurred to Mr Cline, in which a ranula increased so rapidly in bulk in the course of a few minutes, as to force the tongue backwards: this so completely prevented the breathing, that it would have occasioned the patient's death, had not Mr Cline afforded relief by instantly thrusting his lancet into the swelling, and discharging the contents of the tumour.

Of the Sublingual Gland.

The sublingual gland is flat, of an oval form, is longer, softer, and smaller, than the submaxillary gland, and is situated under the anterior part of the tongue, above the duct of the inferior maxillary gland, between the mylo-hyoideus and Genio-glossus muscles. The upper part of the gland projects into the mouth, and is fixed in its place by the reflection of the skin from the under side of the tongue.

The ducts of this gland open into the duct of the submaxillary gland, or a little to the outside of the frænum linguæ. A duct similar to the duct of the submaxillary gland, sometimes opens in the side of the duct of the submaxillary gland.

The smaller salivary glands are placed in the lips, cheeks, tongue, and palate; and are of various sizes, in different individuals, and are placed between the lining of the mouth, and the muscles proper to it.

When the duct of the parotid gland has been exposed, an attempt has been made to ascertain the quantity of saliva, which is secreted by that gland in a given time, and during meals. It has been stated, that in a quarter of an hour ℥ii of saliva have been secreted. It has been supposed, that the pressure of the under jaw, and muscles connected with it, increases the secretion of the saliva. But it may be observed, that the saliva is secreted, and in considerable quantity, though the jaw be not moved, as I had occasion to notice particularly, in the case of a man I visited with Mr Bryce and Dr Gardiner, who divided his windpipe and gullet, and whose life was maintained by broths, soups, and other fluids injected into the stomach, through a tube. Whenever any of the above fluids reached the stomach, immediately a considerable quantity of saliva was discharged. It merits particular notice, that this patient's appetite continued good, and that he did not suffer from the slightest degree of weakness or indigestion, notwithstanding his constant confinement for some months in prison, and though very little or none of the saliva reached the stomach. On the contrary, he daily gained strength, and when I met with him in the street about fourteen months after he had divided his gullet, he was one of the most athletic men I have seen.

It had been impossible to reunite the upper and under parts of the gullet, and he continued to feed himself through a bent silver-tube.

Hence it may be inferred, that the saliva is not essential to digestion. Besides, pressure made on the parotid gland, tends to lessen the quantity of saliva secreted, and ultimately to stop the secretion of saliva. This led Mr Desault, with the view of removing salivary fistulæ, to compress the parotid gland, and, by continuing the pressure and increasing it, the parotid gland was entirely absorbed; none of the saliva passed into the duct, and the fistula was cured.

Chemical Analysis of the Saliva.

Saliva appears to be a solution, in a large quantity of water, of albumen, mucus, and certain saline substances, compounds of phosphoric and muriatic acids; with soda, ammonia, and lime. The proportions are conjectured by Dr Bostock to be about eighty of water, and eight of coagulated albumen; eleven of mucus, and one of saline compounds*.

Berzelius has published the following analysis of the saliva.

Water,	992.9
A peculiar animal matter,	2.9
Mucus,	1.4
Alkaline muriates,	1.7
Lactate of soda and animal matter,	0.9
Pure soda,	0.2
	1000

Mr Brande discovered, that when saliva is exposed to the galvanic fluid, even after having been first boiled in water, it gives an abundant coagulation, and a separation of alkali round the negative pole, though neither acids nor any of the common agents shewed the presence of albumen. Hence this substance may form a part of an animal fluid, and yet be not discoverable by the common tests.

* Vide Murray's Chemistry, third edition, vol. iv. p. 537.

Those stones which sometimes are found within the ducts of the larger Salivary Glands, are of a white colour, and of different sizes; and, according to Fourcroy and Vauquelin*, consist of phosphat of lime, united to a membranous substance.

SECTION VII.

OF THE PHARYNX AND GULLET.

Of the Pharynx.

The Pharynx, a musculo-membranaceous extensible sac, is placed nearly in a line drawn through the middle of the body, and is connected by a loose band of cellular substance with the anterior part of the vertebræ of the neck.

In form, it has been compared to an elongated funnel, but the simile is not quite accurate, as it varies in breadth. The upper part of the pharynx is equal to the distance between the pterygoid processes of the sphenoid bone: behind the thyroid cartilage it is somewhat larger, from which place it is gradually contracted as it descends; so that it resembles a funnel.

The pharynx is firmly connected to the basilar process of the occipital and sphenoid bone above: laterally it is bounded by the pterygoid processes of the sphenoid bone, the cornua of the os hyoides, the carotid arteries, jugular veins, and paria vaga of the 8th pair of nerves; and nearly opposite to the fifth vertebra of the neck and under part of the cricoid cartilage of the larynx, the gullet takes its origin from it.

The pharynx, the medium through which the air passes into the lungs and the food into the gullet, communicates with the following parts, which may be readily seen by opening it from behind, after having removed the vertebræ of the neck. By such a view, the oval-shaped cavities which communicate with the back of the neck are seen, the trumpet-shaped opening of the Eustachian tube, which is bordered by cartilage, and hence always kept open; the soft palate, with the isthmus faucium under it.

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* Vide Fourcroy, ix. p. 367.

The epiglottis, covering the projecting larynx, is seen connected with the tongue, at the fore-part of the pharynx, but when the tongue has been pulled forwards, the epiglottis is raised.

The larynx occupies the fore-part of the pharynx; and hence is raised at the same time as the pharynx.

The internal membrane of the pharynx is a mucous membrane, and it is lined by a thin cuticle.

The pharynx is covered behind by a thin, though very distinct, stratum of muscular fibres, which follow an oblique course.

The fibres of the right and left sides meet together in the middle, in a white longitudinal line.

Anatomists who preceded Albinus, divided this stratum into eight muscles, which they named from their attachments, and described these as distinct muscles, under the names Cephalo-Pharyngei, Pterygo-pharyngei, Mylo-pharyngei, Glosso-pharyngei, Hyo-pharyngei, Syndesmo-pharyngei, Thyro-pharyngei, and Crico-pharyngei.

Modern authors have divided these into three muscles only, under the names of Constrictor Pharyngis Superior, Medius, and Inferior.

As all these fibres have a similar insertion, and are subservient to a similar purpose I shall describe them as one muscle only.

The upper part of the constrictor pharyngis takes its origin from the basis of the cranium, from the jaws, palate, and root of the tongue; it surrounds the upper part of the pharynx; and the lower portion of the muscle arises from the thyroid and cricoid cartilages of the Larynx, and passes forwards to meet with its fellow. This stratum of muscular fibres contracts upon the bolus of food, and pushes it downwards into the gullet.

Stylo-pharyngeus.

This muscle takes its origin from the styloid process of the temporal bone; and, passing downwards and forwards, is fixed into the side of the pharynx, and into the back-part of the thyroid cartilage of the larynx.

This muscle elevates and dilates the pharynx, and also the thyroid cartilage.

Of the Gullet.

The Gullet, or Œsophagus, is a musculo-membranaceous and very extensible canal, which is connected loosely to the neighbouring parts; extending between the pharynx and stomach, and between the fifth cervical and ninth dorsal vertebra. When the gullet is constricted, the canal above the seat of the disease is often much expanded. I have described a case, in which the enlargement was so great, that the patient could retain nearly a pint of fluid for ten minutes, during which he conversed with his friends *.

It is placed behind the windpipe, and between it and the vertebræ of the neck, inclining rather to the left side; and, from the fifth to the ninth vertebra, it inclines rather to the right side, to make way for the aorta.

Within the thorax, the gullet is lodged within the posterior mediastinum, from which its sides receive a covering.

The gullet then inclines somewhat forwards from the spine, and passes through the cardiac opening of the diaphragm.

In its collapsed state, it is nearly flat, both before and behind; but when extended, it assumes nearly the form of a cylinder, excepting where it passes through the diaphragm, where it is somewhat contracted.

The Œsophagus has five coats. The external coat is cellular, and unites it to the spine behind, and to the trachea before. The second coat is composed of distinct fasciculi of muscular fibres, which follow a longitudinal direction; and, within these, there are much thinner muscular fibres, which describe portions of a circle around the gullet.

These muscular coats are connected by loose bands of cellular substance to the innermost coat; so that the gullet, when divided, seems to be a double tube.

The innermost coat is a mucous membrane; is of whitish colour, and has a number of longitudinal folds; it is very dilatable; and, when the gullet is expanded, the folds disappear.

* Vide my Morbid Anatomy of the Gullet, &c.

Between the coats of the gullet, there are a number of mucous glands, the ducts of which open. Upon the surface of the innermost coat, these are most conspicuous at the junction of the gullet with the stomach.

In the class Amphibia, a liquor, which possesses a solvent power upon animal substances, is secreted from the gullet. I had occasion to open the gullet of a large snake, within the gullet of which I found the body of a frog half dissolved.

The mucous membrane of the gullet is lined by the cuticle, which forms at the cardiac orifices of the stomach a number of denticulated folds, which I discovered, and represented by a plate in my thesis De Dysphagia.

The muscular contraction of the gullet is not under the dominion of the will.

Of Swallowing.

When the bolus of food has been masticated, and mixed with the saliva, it is put upon the point of the tongue, which is elevated; and by the stylo-glossi, mylo-hyoidei, genio-hyoidei and digastric muscles, the pharynx is elevated, and at the same time expanded, in order to receive the bolus of food.

By the retraction of the tongue, the bolus of food is pressed into the pharynx. The velum pendulum is raised by its levator muscles, by which the passage into the nostrils is shut.

The pushing the tongue backwards has the effect of pressing down the epiglottis, and of thereby shutting the passage into the windpipe, to which the elevation of the larynx, which, from its connection with the pharynx, must be raised along with it, essentially contributes. Indeed, the elevation of the larynx *is sufficient to shut the epiglottis*, as may be seen in the dead body, by fixing the tongue to the palate.

Thus, the bolus of food passes into the pharynx; and by the successive contraction of the muscular oblique fibres of the parietes of that organ and of the gullet, it is propelled into the stomach. That it does not descend into the stomach on account of its weight, is obvious, from our being able to swallow solids, or even fluids, with the body inverted; from a spasm or palsy of the pharynx and gullet impeding deglu-

tition; and from animals generally feeding with the head lower than the rest of the body.

Such being the means by which the bolus of food passes into the gullet, it follows, that when these muscles become paralytic, or are spasmodically contracted, or when any swelling or tumour obstructs their action, deglutition must be much interrupted, or wholly impeded.

The palsy and spasm of the muscles is sometimes only of a few hours' duration; but, in other cases, it lasts for weeks or years *.

There are instances of children born without the Œsophagus.

"A male child was born in August 1820, at the full period of utero-gestation. It was of the full size, and took the breast with avidity; but each time, the milk was immediately returned by the nose and mouth, with rattling in the throat, and symptoms of impending suffocation. It lived in this state for eight days; during which, the alvine and urinary secretions were regularly voided, although in smaller quantities.

"On dissection, the stomach was without a cardiac orifice; and at this part was united to the diaphragm by means of cellular tissue. The lung on the right side was distended, and presented a reddish colour; that on the left was compact, and dark in its appearance; hence the child had only breathed with the right lung. The œsophagus was entirely wanting; and the pharynx formed a cul-de-sac at its inferior part †.

"An instance entirely similar to the above occurred to Mr Hallam of Walworth. The child lived six or seven days. During that time, whatever was attempted to be given was returned in the manner already described. The alvine and urinary secretion was regularly voided, but in smaller quantity. On inspection after the child's death, the œsophagus was found wanting."

These cases are interesting, chiefly on account of the regular appearance of alvine evacuations, the greater part of which must have been formed by secretions from the mucous surface of the alimentary canal, and by the bile and pancreatic liquor.

* Vide my Morbid Anatomy of the Gullet, Stomach, and Intestines.

† Hufeland's Journal, 1821.

CHAP. III.

OF THE ORGANS OF CHYMIFICATION AND CHYLIFICATION.

SECTION I.

OF THE REGIONS OF THE ABDOMEN AND OF THE PERITONÆUM.

THE abdomen is that part of the body situated between the chest and pelvis. It has commonly been described as the largest *cavity* of the body *, and its dimensions are occasionally augmented by the distention of the bowels proper to it.

The abdomen is bounded behind by the spine and muscles of the loins; and at its sides and in front, by muscles, which therefore have been called Abdominal Muscles. Above, it is bounded by the muscle, called Diaphragm; and below, by the bony circle which forms the upper aperture of the pelvis.

In order to describe more accurately the situation of the different bowels of the abdomen, anatomists have divided it into certain regions or compartments, by lines drawn artificially across it. They draw one line from the cartilage of the eighth rib of one side, to the cartilage of the same rib of the opposite side; the space above the middle of which line, viz. in the angle made by the meeting of the cartilages of the ribs with the sternum, has been called the Epigastric Region; and the spaces on each side of that region the Hypochondriac Region.

They draw another line across the under part of the belly, between the anterior spinous processes of the ossa innominata.

* I have not used the word *cavity*, because there is no cavity of the abdomen; for the parietes of the abdomen, and their contents, are in immediate contact, and constantly act and react upon each other.

The middle space above that line has been called the Umbilical Region, and the lateral spaces the Lumbar Regions: the middle space below that line has been named the Hypogastric Region, and the lateral spaces the Iliac Regions.

The muscles which constitute a part of the parietes of the abdomen, have been already described; we, therefore, proceed to describe the thin membrane which lines those, called the Peritonæum.

Of the Peritonæum.

The peritonæum is a tough elastic semitransparent serous membrane, which is externally connected by small bands of cellular membrane to the adjacent parts, but internally is very smooth, and constantly kept moist by a serous fluid, which is discharged upon its inner surface, by the exhaling branches of the arteries, probably by a kind of infiltration. As fast as this serous fluid is exhaled, it is absorbed; but we neither can see the exhaling branches of the arteries, nor the vessels which absorb this serous fluid. There is an exact balance preserved, during health, between the quantity of the fluid that is exhaled and absorbed, and any preponderance to either side gives rise to disease.

The visible bloodvessels of the healthy peritonæum are few in number, and of small size, but inflammation renders these very conspicuous; they describe an intricate net-work, and generally secrete coagulable lymph.

Serous membranes possess, in their sound state, but a small share of sensibility; and the nerves proper to these, are but of small size; but, when inflamed, they become very sensible: thus a patient labouring under peritonæal inflammation cannot bear even the slightest pressure upon his belly. The peritonæum serves to support, connect, and to fix in their respective places, the several bowels of the abdomen, to the greater number of which it also gives a partial covering: the bowels, therefore, are not within the cavity of the abdomen, but, strictly speaking, external to the peritonæum. As the internal surface of the peritonæum is smooth, and constantly kept moist by a serous fluid, the several bowels may

readily undergo a change of place, without suffering from friction; this membrane also gives a lining to the parietes of the abdomen; and hence forms the hernial sac when the bowels are protruded.

SECTION II.

OF THE HUMAN STOMACH.

The bowels of the abdomen being very moveable, are liable to change of place, from the pressure of the atmospherical air, and from the condensation of the air included within the stomach and intestines; hence in the greater number of engravings, the bowels of the abdomen are represented too low down, and not situated as during life.

Some years ago, a very favourable opportunity presented itself to me for examining the bowels of the abdomen immediately after death; and, in subjects in the full vigour of health, the cause of whose death could have occasioned little injury to the organic structure. I therefore availed myself of so favourable an opportunity, and soon afterwards published engravings of these parts; which had the additional recommendation of exhibiting what may be called the natural structure, and consequently of being a more exact type of nature than usually occurs.

Every part of the alimentary canal, in the higher orders of animals, is not equally capacious. The term *Stomach* or *Stomachs* has been applied to the most capacious portion or portions of this tube; but, in insects, no such distinction is marked, as to the different parts of the alimentary tube.

Within the stomach, what authors have called *Chymosis*, takes place, or that process by which dead animal or vegetable matter is, to a certain extent, rendered fit for the nutrition of a living animal.

No animal of the higher classes can exist, for a long time, without a stomach as an internal receptacle for its food *.

* About 25 years ago, I thought I had discovered an exception to the above

There are instances of deficiency of the human brain, and yet the infant has cried, sucked, and lived for a few days; and also many examples in which, by disease, a portion of the brain, lungs, liver, intestines, have been destroyed, but life has been still continued. But an animal can exist for a short period only, without an internal receptacle for food. There have been some monsters (such as the one described by my Father in the Edin. Phil. Trans., vol. iii.) that seem destined to live only as long as they were connected with the mother, but were totally incapable of independent existence, from having no stomach.

It has been already remarked, that the form, number, and kind of internal receptacle is wonderfully adapted to the peculiar kind of food, and to the peculiar circumstances in which an animal is placed,—a fact rendered very obvious by the change of structure the internal receptacle undergoes, upon a change of food. Thus Mr Hunter found, that the stomach of a sea-gull, fed for a year upon grain, acquired a much greater thickness and strength than that of the same bird fed upon its natural food. In the *camel*, *lama*, and *dromedary*, there are reservoirs connected with the stomachs, capable of holding a considerable quantity of water, and which they can at pleasure express, thus rendering these animals capable of existing, for a considerable length of time, without a supply of water.

According to Sir Everard Home, when the camel drinks, it conducts the water, in a pure state, into the second cavity, a part of it is retained there, and the rest runs over into the cellular structure of the first, acquiring, in its course, a yellow colour *.

The stomach is a musculo-membranaceous bag, which, when

observation. Sir David Dundas of Richmond was so polite as to send to me the body of one of the kangaroos that had died in Kew Gardens. I examined the body of the animal with care; and at first thought the stomach awanting; but soon afterwards discovered my mistake. Upon tracing the gullet and duodenum, I found that these were connected with an organ in size and form very like to the human colon, which I at the time stuffed, and still possess.

* Vide Lect. on Compar. Anat.

moderately distended, bears some resemblance to a cone, bent upon itself, the base of which is on the left side of the body.

There is no organ in the human body which varies so much as to its form, size, and situation, at different periods of life, and in the different sexes. It is generally rounder and more capacious in the male than in the female, and is proportionally shorter and rounder in the infant than in the adult. Use seems to have considerable influence over the form of several of the bowels; hence the different form and capacity which, during the progress of life, takes place in the stomach, intestines, and bladder of urine.

The healthy stomach of an adult, at an average, may be stated to be capable of holding about 8 lb. or 12 lb. of water; but, by disease, it is often so much reduced in bulk, as not to be capable of containing above a few ounces. On the other hand, it is sometimes, like the heart, intestines, and bladder of urine, much expanded, where there is a mechanical obstruction to the exit of its contents.

The stomach is commonly laid transversely across the body, between the liver and spleen, and is retained in that situation by the gullet, duodenum, arch of the colon, omentum, reflected peritonæum, and by the bloodvessels common to it and to the liver, spleen, pancreas and omentum.

The stomach has a left, or larger, or *cardiac*, extremity, which is situated in the left hypochondriac region, in contact with the diaphragm and spleen, and a smaller right or *pyloric* extremity, which lies under the left lobe of the liver, is placed in the epigastric region, and approaches more or less to the right hypochondrium, in proportion to its distention.

But there are many exceptions to the above description of the situation of the stomach. Even when that organ, and also the contiguous parts, were not under the influence of disease, I have seen it laid wholly on the left side of the body. When there is a mechanical obstruction at the pylorus, it sometimes attains, from the weight of its contents, a most extraordinary bulk. The pylorus, then, lies at the navel; and instead of being placed transversely, the stomach lies in the contrary direction.

The situation, dimensions, and relative position of the stomach, vary even when that organ is sound, according to its state of distention; and hence the necessity of describing it both when empty and when full.

The undistended stomach may be said to present an anterior and posterior surface, and to have two orifices, the *cardiac* or left, and *pyloric* or right; by the former of which, it is connected with the gullet, nearly opposite to the ninth vertebra of the back, and by the latter with the intestines. These orifices, when the stomach is empty, are not on the same level, the cardiac being the more elevated. The stomach is also described as having two curvatures; the upper, or smaller, being the sweep which the upper portion of the stomach describes between the gullet and duodenum; and the under, or larger, being the more extensive, or, in the undistended state, the lower line of stomach, to which the greater omentum is fixed, the bond of union between the stomach and transverse arch of the colon. The two opposite sides of the stomach are in contact with each other, when this organ is undistended.

The coats of the stomach, in all men or in all animals, are not of an uniform thickness, nor are they equally thick in every part of the same stomach: they are thickest in robust men, and still more so in the tyger, lynx, and other carnivorous animals; and they are thinnest at the great left sac, and become gradually thicker towards the pylorus.

As the food passes into the stomach, its coats yield to the mechanical distension, and seem at first to be passive; but after a certain time, they contract upon their contents, and adapt themselves to these.

As the stomach is filled, the greater curvature is gradually protruded forwards and upwards, forming a considerable angle with the gullet; and at length it presses on the parietes of the abdomen, so as to occasion a considerable swelling, in which the pulsations of the gastro-epiploic artery, which passes along the greater curvature, may, in emaciated people, be readily perceived.

If vomiting shall take place, when the stomach is very much distended, that organ may be burst, as the angle the

gullet then makes with the stomach is very nearly a right angle.

The pressure of the distended stomach on the liver and pancreas may occasion a diminished secretion of the bile and pancreatic liquor. It also tends to force out the bile which has been accumulated within the gall-bladder, and the blood that is collected within the bloodvessels of the spleen; and, by its pressure on the diaphragm, occasions a temporary difficulty in breathing, in speaking, and in singing.

By the distension of the stomach, the pyloric orifice is considerably elevated by the longitudinal muscular fibres passing between these orifices, along the smaller curvature of the stomach, which, at that time, are evidently put upon the stretch.

Owing to the peculiar arrangement of the muscular strata, the distended stomach has somewhat of a conical figure bent upon itself, so that if it were divided transversely, the cardia would remain with the anterior portion, and the pylorus with the posterior.

When the stomach has been moderately distended, it is sometimes observed to be contracted towards its middle, or about half way between the cardia and pylorus, or it is somewhat contracted in one or two different places.

This contraction of the stomach has been noticed by many anatomists. Mr William Cowper* has described, in his explanation of his thirty-fourth plate, what he has named "*two bunchings in the lower part of the stomach;*" and Sneider and Blasius have mentioned cases in which *the stomach has been divided into three sacs.*

Riolan†, Blasius‡, Morgagni§, Lorry‖, Walter¶,

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* Vide his Anatomy of the Human Body. London, 1698.

† Vide His Anthrop. p. 17. Published 1662.

‡ Vide Lieutaud, Hist. Anat. Med. vol. i. p. 12.

§ Vide Lit. xvi. Art. 38.; xxvi. Art. 31.; xxx. Art. 7.; xxxvi. Art. 3.; xxxviii. Art. 28.

‖ Vide Hist. de la Societ. Roy. de Med. Tom. xi. p. 195.

¶ Vide His Catalog. No. 1572 and 1573.

Ludwig *, Huffland †, and Van der Kolk ‡, have also described the contraction in the middle of the stomach.

This contraction, in the middle of the stomach, is either temporary or permanent; and, according to Morgagni, is connected with a derangement in the functions of digestion. But a contraction in the middle of the stomach is not always to be found.

This contraction, in the middle of the stomach, is most obvious in those instances where the stomach is of unusual size, and where the distance, between the opposite extremities is greater than common; if, after death, the body is examined so late as twenty-four hours, the contraction in the middle of the stomach, is generally not evident.

There is a species of contraction of the middle of the stomach which does not go off, of which I have a specimen before me, while writing these lines, and where the contraction is, at present, quite obvious, though the stomach has been preserved for eighteen months in spirits.

Upon the whole, as we occasionally observe a similar appearance, and to a greater extent, as the consequence of a spasmodic contraction, in the turns of the intestines, both great and small, in the gall-bladder and bladder of urine, when, upon examination, there is no organic disease; as this stricture of the stomach is only observed when the body is opened soon after death, and as it entirely disappears in twenty-four hours, unless when it is the effect of disease, and does not remain until the stomach be destroyed by putrefaction; I am disposed to conclude, that it is the result of spasm affecting particular muscular fibres,—an opinion which receives weight, from there being no peculiar organisation of the stomach or band of muscular fibres, calculated to cause such an unnatural division of the stomach, and as the stricture varies in situation and degree of contraction and extent, in different bodies.

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* Vide Primæ Lineæ Pathol. Lips. 1785, p. 40.

† Vide Journal der Pract. Arzneyk. V. B. P. 823.

‡ Vide Dissert. Groning. 1793.

Of the Coats of the Stomach.

The stomach has four coats, the *peritonæal*, *muscular*, *cellular*, and *villous*.

The peritonæal and muscular coats are not easily separated from each other; but the muscular and villous coats may be readily disjoined, as the cellular coat is of considerable thickness, and admits of considerable extension.

The peritonæal coat has the same general characters as all the other portions of that serous membrane; and the muscular fibres are seen distinctly through it, passing in different directions.

The second coat is made up of distinct muscular fibres, which may be divided into two strata, and which are very apparent in the stomach of a robust man; but, in persons of a debilitated constitution, they are much smaller, paler, and more flaccid, and not unlike to membrane.

The external stratum of muscular fibres is continued from the gullet, and is disposed, in a longitudinal manner, between the cardia and pylorus, and they become gradually thicker as they approach the pylorus.

The internal stratum of muscular fibres is disposed, in an oblique or circular manner, and many of the fibres decussate each other.

By means of the muscular fibres proper to the coats of the stomach, the different parts of the food are turned over and over, and more intimately incorporated with each other, to which the pressure of the diaphragm and abdominal muscles probably contributes in a considerable degree.

The third coat of the stomach consists of loose cellular substance; this concurs with the fourth or villous coat in forming the folds of the stomach, which, when the stomach is empty, are very conspicuous. The greater number of these folds, which are of different sizes, are disposed in the transverse direction; and, between these, there are a number of smaller folds. The larger folds disappear when the stomach has been considerably distended. Even in very fat persons, there is no fat deposited in this coat.

The fourth coat of the stomach is a mucous membrane, termed the Villous Coat.

Dr Carmichael Smyth, in his very valuable paper on the different kinds of inflammation, has observed, that there is some variety in the appearance and structure of the mucous membranes; and, on that fact, explains the greater frequency of peculiar organic derangements in some than in other mucous membranes. Thus the inflammation of the villous coat of the intestines is more common than that of the stomach. There is an obvious difference in the appearance of the mucous lining of the stomach and intestines. This coat is of a redder colour than that of the intestines: from what I have remarked in the stomachs of criminals I examined a few hours only after death, it has a reddish-brown colour; and there are a number of spots on it, evidently formed by extravasated blood, and in which the vessels are disposed in a star-like direction. The red-brown colour of this coat does not go off for years,—a circumstance which has escaped the notice of authors. I have a specimen in which the red colour of this coat is still very obvious, though that portion of the stomach has been preserved in spirits for ten years.

Dr Yellowly has justly observed, "That, in the villous coat of the stomach, appearances of vascular fulness, whether florid or dark coloured, in distinct vessels, or in extravasations of various sizes are not to be regarded as unequivocal marks of disease. They occur in every variety of degree and character, under every circumstance of previous indisposition, and in situations where the most healthy aspect of the organ may be fairly expected *."

According to Mr Hunter, the villous coat of the cardiac extremity of the stomach of criminals, is more or less eroded, in cases of sudden death; but this is an observation which is liable to many exceptions. It has been supposed by some anatomists, that the stomach has a cuticular lining. Whilst examining the structure of the human gullet, preparatory to the publication of my Thesis, I discovered that that tube has

* Medico-Chir. Trans. of London, vol. iv.

a cuticular lining, which extends no farther than the cardiac orifice of the stomach, and is there folded. But the cardiac extremities of the stomach of the horse and hare have a distinct cuticular lining; and hence these form a link between the ruminant and non-ruminant animals, which latter have a distinct cuticular lining over the whole stomach.

About two years ago, I sent to Dr Brewster a portion of the cardiac extremity of the stomach of a criminal, who died in the full vigour of health, and begged that he would carefully examine the internal surface of it. He with great readiness complied with my request; and, after submitting it to the test of polarised light, said that he could not observe any villi upon it, but a reticulated honeycomblike surface.

Mr Bauer's description of the appearance of the internal surfaces of the gullet and stomach corresponds with that of Dr Brewster. The glands situated in the lining of the lower part of the gullet, are said to have the appearance of "infundibular cells, whose depth does not exceed the thickness of the membrane." The structure upon the upper arch of the stomach is said to be *cellular;* and the cells are in the form of a honeycomb, the sides of which are not formed by the doublings of the membrane, for no stretching of the cells alters the form of their orifices, but are regular partitions constructed between the cells." The same structure may be seen extending over the whole surface of the cardiac portion, by a powerful microscope.

"In the pyloric portion, the cells have the same appearance, but there are small clusters, the sides of which rise above the surface, giving the appearance *of foliated membranes.*

"Inthe duodenum this takes place in a greater degree, and the loose edges of these membranes, when entangled in the mucus that covers them, put on an appearance of rounded globular bodies; but these admitted of being expanded, so as to explain the deception *."

In some birds, and particularly in the common *sea-gull* (Larus canus), the glands, at the conjunction of the gullet with the stomach, are easily seen: in the *ostrich*, the glands

* Home's Comp. Anat.

which secrete the gastric juice are of a large size, and their ducts, which open upon the inner surface of the stomach, are quite obvious to the eye.

At the lower orifice of the stomach there is a distinct circular muscle, which has been called *Pylorus*, which is covered by the cellular and villous coats of the stomach, and varies as to form and size*. This circular muscle performs its office so accurately, that, with a few exceptions †, substances do not pass out of the stomach until they have been, to a certain degree, digested; and in birds that swallow stones along with their food, we rarely meet with these stones in the intestinal canal.

The bloodvessels of the stomach are large and numerous, and freely communicate with each other. The arteries are derived from the cœliac artery, and the corresponding veins assist in forming the vena portarum. The stomach receives nerves from the eighth pair, and also from the great sympathetic nerve.

The lymphatic vessels of the stomach are numerous, and they pass through small glands, situated on the smaller and larger curvature, and afterwards go to the thoracic duct.

SECTION III.

OF CHYMIFICATION, OR OF THE CHANGES WHICH THE FOOD UNDERGOES WITHIN THE STOMACH.

The food within the stomach is converted into a greyish pulpy mass, called *Chyme*.

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* Soemmering, (de Corporis Humani Fabrica, tom. vi. pag. 222.) speaking of the Pylorus, has observed, "Forma, magnitudo, crassities atque ostium hujus pylori ad sequentes tres varietates præcipuas redigi possunt: Interdum integer quidem annulus est, sed tenuis, ex orbibus concentricis formatus, amplus spatioso admodum ostio. Interdum pars annuli aliquo reliquo ambitu latior est, et ostium modicè amplum ovatum. Interdum annulus parvus, oblongus, ovatus ostio oblongè ovato, et valde angusto hians."

† I cannot agree with Majendie, in considering the term Pylorus or Porter as inapplicable to the pylorus, though such substances, as plum or cherry stones, occasionally pass through it.

There is only one way of arriving at a precise knowledge of the appearances of the contents of the stomach; for I hold all observations deduced from examining the contents of the stomach after vomiting, or from those cases in which there has been an aperture in the coats of the stomach and parieties of the abdomen, as calculated to lead to error. That is, to examine the contents when taken a few hours after death from the stomach of a person who, in the prime of youth and health, has suffered a violent death, about two hours after having taken food; or, to feed an animal a few hours before killing it.

It is also difficult to ascertain the length of time which the food is detained within the stomach.

It has been supposed, that as vomiting takes place in the case of obstructed or scirrhous pylorus, in the course of two or three hours after eating, that the food is detained within the stomach for that space of time; but there must be many exceptions to this observation.

Repeated observation and experiment have proved, that the contents of the stomach do not pass into the intestine, in the order they have entered it; but only after having undergone the necessary change within the stomach.

The rapidity with which different kinds of food is converted into chyme, is very various in different individuals, and even in the same individual, at different times.

The contents of the stomach are found, more or less, dissolved in the opposite extremities of that organ, which, according to some authors, during chymification, is divided at, or near to its middle, into two pouches, a *cardiac* and *pyloric*; and, in the latter, the contents are found to be in the state of the more perfect solution; and that part which is most superficial is the softest.

In the living animal, the contents of the stomach may be observed passing from left to right, or towards the pylorus; and they are turned over and over, so that the central part becomes the more superficial.

If it be legitimate to draw a general conclusion from an individual example, it appears from a case, that fell under the

notice of Dr Hastings of Worcester, that ulceration of the villous coat of the pyloric extremity of the stomach does not impair the digestive powers of the stomach: hence the conclusion, that the cardiac extremity of the stomach is the principal seat of chymification.

It is foreign to the object of an elementary treatise upon anatomy, to enumerate those substances which are with ease or difficulty converted into chyme.

I shall, therefore, content myself by stating, that fat, tendon, and unboiled vegetables, and unchewed portions of food, resist the action of the gastric juice, for a much longer time than portions of flesh which have been fully masticated. Pieces of bone, the entire seeds of fruits, or cherry stones, pass through the body unchanged. The reader will find much useful information on this subject in Mr Gosse's Catalogue; the result of many experiments that author made upon himself, and which is worthy of the serious attention of the physician who is about to prescribe for a dyspeptic patient.

During the formation of chyme, a small portion of air is found within the stomach, which, according to Chevreul, consists of

Oxygen,	11.00
Carbonic acid,	14.00
Pure hydrogen,	3.55
Azote,	71.45
	100.00

SECTION IV.

OF THE MEANS BY WHICH THE FOOD IS CONVERTED WITHIN THE STOMACH INTO CHYME.

Of the Gastric Juice.

Besides the mucus, the fluid called Gastric is found within the stomach.

On examining with great attention the internal surface of the stomach, it is found to be very largely supplied with bloodvessels; but whether the gastric juice be secreted by the arteries, or by glands, has not yet been ascertained. This latter opinion is rendered probable, by observing that in some birds a number of glands are placed at the lower orifice of the gullet; and in others, as in the ostrich, glands of a large size are placed between the coats of the stomach, the ducts of which are large.

We are not yet fully acquainted with the nature of the gastric juice. When obtained from animals that have been kept fasting for some time before being killed, it is nearly transparent, and has somewhat of a saline bitterish taste.

Dr Steven's experiments with hollow perforated silver balls have pointed out, that there is a considerable distinction between the gastric juice of a carnivorous and graminivorous animal.

He gave to oxen and sheep such balls filled with animal substances: these substances *were not dissolved;* but when the balls were filled with grass, *it was consumed.*

From the experiments which Mauquart and Vauquelin made on the gastric juice of sheep, it appears that sometimes the uncombined phosphoric acid is present; and from the experiments of Spallanzani, it seems to partake neither of an acid nor of an alkaline nature, for it contains neither acid nor alkali in an uncombined state.

By the action of acids, albumen is discovered in it.

According to the latest experiments of Dr Prout, of which he gave an account to the Royal Society of London, the contents of the stomach during digestion always contain *the free muriatic acid.* The contents of a stomach having been digested in distilled water, the solution obtained was divided into four equal parts. One of these, evaporated to dryness, burnt, and examined in the usual way, gave the quantity of muriatic acid in combination with fixed bases. A second, being previously saturated with an alkali, was treated in a similar way, and gave the whole quantity of muriatic acid in the stomach. A third, carefully neutralized with a known solution of alkali, gave the quantity of free acid. The fourth

was reserved for any required experiment. In this way, Dr Prout ascertained that the unsaturated muriatic acid in the stomach was always considerable; and, in one case, twenty ounces of a fluid from a very deranged stomach, afforded him above half a drachm of muriatic acid, of specific gravity 1.160 *.

The gastric juice, particularly in young animals, has the property of coagulating milk. The coagulated milk thrown up by infants immediately after sucking, and the well-known use of the stomach of the calf in our dairies, sufficiently prove this fact.

Dr Young found that the stomach retained this power after being repeatedly washed, and that the infusion of a portion of the stomach employed as runnet, did not lose its coagulating power though mixed with an alkali.

Brugnatelli informs us, that the gastric juice of carnivorous animals, as hawks, has a bitter taste and pungent smell; is not at all watery; and contains an uncombined acid, with a small quantity of the muriate of soda.

On the other hand, Carminati informs us, that the gastric juice of sheep is watery, has a bitter taste, and contains ammonia, an animal extract, and a large proportion of the muriate of soda.

From the above there is reason to conclude, that the gastric juice is adapted to the food of the animal, *and therefore different in the different classes of animals.* There is likewise reason to suppose, that it is somewhat different in different individuals, and in the same individual at different times.

Most of the graminivorous quadrupeds, when young, are fed chiefly on milk, and some birds chiefly on animal substances.

A chick for the first few days is nourished by the yolk of the egg; and the pigeon feeds its young at a very early period with a curd formed in its crop, mixed with grain, till they arrive at a certain age, when they are fed on grain alone; proving, more clearly than Spallanzani and Mr Hunter's

* Vide the Journal of Science, Literature, and the Arts, vol. xvii. p. 181.

experiments on the eagle, that the food of an animal, intended to live ultimately on vegetables, may, in the earlier period of its existence, be purely animal, or at least of a mixed nature.

My Father, at a very early period of his life, considered, that the change which the food undergoes within the stomach, was owing to the influence of the gastric fluid. The following is an extract of his 123d Lecture, which was written in shorthand by Mr Thorburn, 1773 *.

"Within the stomach it (the food) is incorporated with the drink; and it is there subjected not only to the action of the muscular coat of the stomach, but also to the agitation of the arteries running upon its coats; and to the alternate motions of the chest in respiration. At the same time it is exposed to the heat of our body; which, joined to moisture and motion, we must suppose to have an effect to a certain extent. But we are by no means to conceive that the circumstances I have mentioned are the most essential. For without almost any of them, digestion takes place in one or other of the kinds of animals.

"The chief cause is the humours of the stomach *acting as menstrua*. Dr Young has shewn, in his *Thesis de Lacte*, that the humours of the stomach of animals, before they have tasted of food, or whilst in the fœtus state, possess the power of curdling milk. He observed this even in those animals that never taste of milk as their natural aliment, as the birds. So this gives a suspicion that this humour is materially different from the merely watery parts of the blood.

"Anatomists of the last century have observed in the stomach of the fish, the parts of a lesser fish, even the bones, melting down in the space of a few hours; that the part included in the stomach was dissolved, whilst the part lodged in the œsophagus remained entire.

"I have mentioned in a former lecture the experiment I made on a dog, of giving him hard bones, which were dis-

* Many copies of these notes of Lectures, taken by Mr Thorburn, have been sold. A few years ago, they were advertised as publicly as any printed book.

solved *. The inner coats of the several stomachs of the ruminant animals differ from one another, and the food is in different states within these.

"In the next place, the appearance of the stomach in different kinds of animals varies according to the nature of the food; and in fact, it is found to possess very different powers. So Reaumur inclosed grain and flesh in cylinders of iron perforated with holes, and gave them to the carnivorous and granivorous birds; the flesh in the carnivorous soon melted, and the grain in the granivorous. But reversing the experiment, the change was much less perceptible; so the liquors of the stomach much evidently act as powerful menstrua. I had observed the destruction of the coats of the stomach in a few persons, but at that time I considered this rather as the effect of the disease; not conceiving that the quality of the *menstruum* would have had so great an effect after death. In one case, however, there was great reason to suppose that the change had begun during life. A lady about twenty years of age had considerable oppression and pain about the stomach, and died suddenly. The body was opened thirty hours after her death, and the coats of the stomach were found destroyed. So I suspect that this might happen before death †."

There is still farther evidence as to the influence of the gastric

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* Dr Stevens in his celebrated Thesis De Alimentorum Concoctione, published Edinburgh 1777, has made particular mention (page 34.) of the experiments of my Father. He observes, "Quinetiam Monroius clariss. hypotheses vanas et inutiles spernens, et veritatem, ut philosophum decet, per res veras et observationes solas comperiendi desiderio ictus, hanc opinionem, multis gravibusque argumentis sustinere conatur, et quotannis, prælectionibus in publicis, quorundam periculorum a se factorum meminit, qua ad hanc theoriam magis etiamnum illustrandam plane conferunt."

Anno 1764, "Compluria ossis femoris ovini frusta, pondere diversa, tria forma circularia, eodem tempore, cani dedit. Quo intercempto et inciso, ita sese habuerunt: Omnia, præter circularia quorum quoque nihil, *nisi lamina externa æque ac charta tenuis superfuit, ex toto consumpta sunt.*

"*Denique*, vir celebris Hunterus in Trans. Philos. quasdam observationes nuper edidit, quæ *eandem opinionem* plurimum firmant," fully confirmed the above supposition.

† The cases published by Dr Carmichael Smyth, in the London Medical Communications, have fully confirmed the above supposition.

juice on digestion. If vomiting be artificially excited after long fasting, when the cravings of hunger are urgent, these subside, according to Dr Wilson Philip, and the food which is taken a short time afterwards, ferments within the stomach, as is evident by the flatulence it creates, and the accompanying acid eructations. A still stronger argument, for the same opinion, is derived from the effects which follow the interrupting the secretion of the gastric juice, by the division of the eighth pair of nerves. Such an experiment puts an end to the digestion of food within the stomach, which, in these circumstances, instead of proving nutritious, provokes constant nausea and vomiting.

It is remarkable, and worthy of particular mention, that I I have found repeatedly that the dividing the sympathetic nerves of rabbits, which also supply the stomach, does not in the slightest degree impede digestion.

I have found that the secretion of the gastric fluid is also arrested by *an acute inflammation of the pia mater at the connection of the eighth pair of nerves with the medulla oblongata.*

There are certain symptoms which characterise such inflammation: these are, extreme restlessness, frequent agitation of the body, starting and croupy cough, but which is not accompanied by difficult breathing, constant nausea, frequent vomiting, and the contents of the stomach are rejected unchanged, though they have been ten or twelve hours within that organ. The skin is at the same time hot, the face flushed, and the pulse quick and hard. In the progress of the disorder, which generally runs its course in three or four days, the croupy cough goes off, and this is succeeded by symptoms of oppressed brain.

The gastric juice has been observed likewise to act still more slowly in those animals, that are, during the winter, in a torpid state, and to have its activity again increased, by exposing them to a greater degree of heat *.

* My Father, during a severe winter, (1764), kept a hedgehog in a room where there was no fire, from the month of November till March. He placed near the animal boiled beef, bread, cheese, potatoes, water, and straw. About

The most remarkable circumstance in the history of the gastric juice is, *that its power is purely chemical; for it operates as powerfully upon the animal fibre out of the body, as within the stomach of a living animal;* and actually is sometimes observed to dissolve the stomach itself after death.

From this fact, it is obvious, that its operation is confined to the dead animal fibre, and that it has no effect upon the living. This inference may appear to some contradicted, by an experiment of Dr Stevens, who inclosed a living leech within a silver hollow ball, which the stone-eater swallowed. Upon examining the leech within the hollow sphere, after it passed through the alimentary canal of the stone-eater, it was found to be nearly dissolved; for nothing remained except a viscid black mass.

This experiment, though ingenious, is not perfectly conclusive of the fact in question, as the leech was probably killed within the stomach, and afterwards acted upon by the gastric juice, like dead animal substances.

The gastric juice possesses another very remarkable property; it is antiseptic, and arrests the process of putrefaction in substances in which it had begun.

In short, the gastric juice is not a diluent, but a solvent; and the solvent power of the gastric juice is different in different animals. In the herbivorous animals, it dissolves vege-

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the beginning of December, the hedgehog was affected with an unusual degree of drowsiness. He, however, continued to eat, though more sparingly, till the 25th of that month. From that time till the 8th day of March following, he continued in a profound sleep, except when artificially roused. After being thus roused, he soon walked back to his place of retreat, and resumed his dormant state. On the 25th of December, he weighed thirteen ounces and three drachms; on the 6th of February, eleven ounces and seven drachms; and, on the 8th of March, eleven ounces and three drachms. There was a small quantity of feculent matter and urine among the hay. At the time of his actual reviviscence, no person was present; and, of course, the circumstances attending it are unknown. In the course of three months, the hedgehog neither ate nor drank, but remained constantly in a profound sleep among the straw. Its limbs, however, were never rigid; but it lost two ounces of its weight. *Frogs*, which my Father kept during the winter in a vessel with water, seemed to be in a similar state with that of the hedgehog.

tables only; whilst in the carnivorous and fish, its operation seems confined entirely to animal matter; whereas in man, and animals destined like him to live both on vegetable and animal matters, its solvent power seems equally effectual on either; for it is adapted to the digestion and assimilation of certain vegetables, as well as animal matters.

It seems, that, as yet, we are much in the dark as to the nature of the gastric juice, which probably differs very much, not only in animals of different classes, but in animals of the same class, some eating that kind of food with impunity, which proves a poison to others; a fact which I have already taken notice of in my Thesis, "Quasdam tamen res quibusdam animalibus lethales, aliis animantibus minimè nocere, notandum est; sic, capri cicuta, vaccis perniciosissima, impune vescuntur; porci hyoscyamo pinguescunt; equus vitri antimonii quantitatem quæ centum homines necaret, impune tolerare potest; canis opii copiam homini huic non assueto lethalem, sine periculo devorare potest: Contrà autem, dosis jalapæ aut nucis vomicæ, aut amygdalæ paucæ amaræ, eundem convellerent aut extinguerent."

It may be added to this chapter, that there are many extraordinary examples of animal life being preserved for a long time without food. One of the most remarkable of these, is mentioned in the forty-first number, and 396th page, of Dr Thomson's Annals of Philosophy. A hog was buried in his stye, by the fall of a part of the chalk-cliff under Dover Castle, and 160 days after the accident, the animal was dug out in a very emaciated state, and had lost about 120 lb. of its weight.

SECTION V.

OF THE INTESTINAL CANAL.

The length and capacity of the intestines bear a ratio to the kind of food. In animals purely carnivorous, they are not only much shorter, but also less capacious than in graminivorous animals; and those of omniverous animals, as man, hold

a medium between these, and measure, in the adult, about six times the length of the body.

The intestines next the stomach are of smaller size than those near to the lower end of the tube; and hence they have been divided into the smaller and larger, the former of which are subdivided by anatomists into three portions, called the *Duodenum*, *Jejunum* and *Ileum*. The first named portion has been so named from its length, which is equal to the breadth of twelve fingers; it is the most capacious part of the smaller intestines, and has hence not improperly been called by RIOLAN the *Assisting Stomach*. This intestine follows a tortuous course; it has been more fully described by my Grandfather than by any other author, which has led me to insert his description of it.

From the pylorus, the duodenum descends obliquely to the right side, with the anterior lamella of the omentum fixed to its inferior part; and the little omentum proceeding from the opposite part to connect it to the liver.

After this, the duodenum is involved about an inch and a-half in a doubling of the omentum, and then enters into the duplicature of the mesocolon, where it cannot be seen without dissecting away that fatty membrane. It descends in this cellular sheath, till it is almost contiguous to the great sac of the colon, which properly is the human cæcum. In this descent, the colon lies before it; the biliary duct, hepatic artery and nerve, vena portarum, and emulgent vessels, are behind it; the liver, gall-bladder, and right kidney, are on its right side, and the pancreas is on the left. This gut makes several turns in this progress; for it is raised into a convexity forwards, where it passes before the vessels of the liver. Immediately after it bends backwards, and to the right side, till it approaches the right kidney; and then turns forward, and a little to the left, in its course towards the great sac of the colon. The duodenum then makes a considerable curve to the left side, where it is involved in cellular substance, which may be looked upon as the common root of the mesentery and mesocolon.

In the convex side of this curve, the thick extremity of the larger pancreas and the little pancreas are lodged; the superior mesenteric artery and vein coming through the notch between the larger and lesser pancreas, hang loose before the gut here, and the ductus communis cholidochus, after passing behind the gut a little higher, unites commonly with the pancreatic duct, very little above the lowest part of the curve; and, after passing obliquely through the coats of the gut, the two ducts open by one common orifice in the posterior part of the duodenum. After the curve above described, the duodenum is involved in the root of the mesentery, and mounts obliquely towards the left side; it rises forwards, and ends in the jejunum.

Of the Jejunum and Ileum.

The Jejunum and Ileum constitute the greater share of the intestinal tube, and describe many turns, which fill the greater part of the umbilical and hypogastric regions, and also fall down into the cavity of the pelvis.

As the different portions of the intestinal tube are fixed to the body by a long mesentery, they are readily pushed out of their usual place, when any of the bowels of the abdomen or pelvis have attained an unnatural bulk; or when much compressed by the diaphragm, they are often forced into a hernial sac; and more especially the ileum, which, from having the longest mesentery, is, therefore, the most moveable portion of the smaller intestines.

The peritonæum, the bond of union between the several bowels of the abdomen, and the medium by which they are fixed to the body, is occasionally much elongated; hence the liver, spleen, and caput cæcum coli, which are commonly fixed down to a certain place, have sometimes got into a hernial tumour.

The peritonæum even admits of a transposition of the bowels; hence the colon of the left side has passed into a hernia at the right groin, or that of the right side has got into a hernia of the left side.

The elongation of the peritonæum is still more remarkable;

as when a hernial tumour has attained so great a bulk, as to hang down beyond the knees, and contains the greater part of the bowels of the abdomen.

By repeated observation, it has been discovered, that every part of the intestinal tube is not equally necessary to life; and also, that the smaller intestines constitute the most important part of it. Life has been often prolonged for months, though the contents of the larger intestines have been discharged at the groin, through an unnatural opening; and it has also been found, that the chance of recovering is the greater, the nearer the opening is to the anus; and, on the other hand, when it becomes necessary, in consequence of the constriction of some part of the gullet, to endeavour to support the corporeal strength by nutritious glysters, that these are of little avail beyond a few weeks.

Of the Ilio-Colic Valve.

This valve, which is of different construction in different animals, and more or less perfect as a valve, is placed at the conjunction of the smaller with the larger intestines; and where the ileum opens into the left and posterior side of the caput cæcum coli, forming an acute angle with the colon.

The muscular, cellular, and villous coats, enter into the composition of the valve, which is composed of two folds of the internal and cellular coats of unequal length, placed transversely, which project for about three-quarters of an inch into the cavity of the caput cæcum coli; and each fold is composed of small internal laminæ.

The length and breadth of the folds are various; as also the size of the interposed aperture.

Sometimes the lower fold is long and broad, and the upper one short and narrow.

Upon making a longitudinal section of the termination of the ileum in the caput cæcum coli, the lips of the valve are seen projecting into the caput cœcum coli. If a liquor be thrown into the smaller intestine, the lips of the valve are separated from each other, the aperture of the valve becomes larger, and the greater the quantity of liquor thrown into it,

the more the lips of the valve are separated from each other; but when the liquid is injected in the contrary direction, or from the larger intestine, the lips of the valve are pressed towards each other; and the greater the quantity thrown up, the more the sides of the valve are pressed against each other. The peritoneal coat, extending from the ileum to the caput cœcum coli, retains these portions of intestines in their relative positions.

Of the Appendix Vermiformis.

The Appendix Vermiformis is a conical tube, about five inches long, appended to the caput cœcum coli, to the posterior and left part of which it is fixed by its mesentery; and from its small size and tortuous course, it bears some resemblance to an earth-worm.

The coats of this appendix are similar to those of the intestines.

Upon opening this small tube, we find within it a number of mucous glands, and a small quantity of fat, and of cellular substance, but commonly no feculent matter.

The appendix vermiformis is proportionally much larger in the fœtus than in the adult; and hence has, by some authors, been considered as a reservoir for the fæces during gestation. My grandfather has remarked, "I never saw the appendix vermiformis of any of the human fœtuses which I have dissected distended with meconeum."

Hardened fæces sometimes get into this appendix in the adult, and prove a source of great irritation, and even of inflammation of the intestine. A case of this description lately occurred to Dr Graham, my colleague. The appendix vermiformis sometimes proves a cause of strangulation and mortification of the neighbouring intestine.

My colleague Dr Graham, had a patient under his charge, who died with all the symptoms of ileus. Upon dissection, a considerable portion of the smaller intestine was found sphacelated, and no adequate cause could be assigned for it, excepting a deficiency of the mesentery of the appen-

dix vermiformis, through which the intestinum jejunum had passed.

On account of an irregular contraction, one part of the intestine sometimes gents within another; and on account of the very unequal diameter of the smaller and larger intestines, it not unfrequently happens, that the smaller intestine passes within the beginning of the larger intestine, constituting the disease called *Intus-susceptio.*

The intestine generally passes into that beneath it, but sometimes in the reverse direction.

This disease is most frequent during infancy; and the included portion may, in most instances, be readily disengaged, or dissected, there being no unnatural thickening and inflammation, and but a slight diminution in the calibre of the intestinal canal; but in the adult, the disease assumes a more formidable aspect; the displaced intestine is firmly fixed in its unnatural situation in consequence of inflammation, swelling, and the accretion of parts.

The intus-suscepted portion has sometimes been discharged by stool, yet life has been continued, though eight or ten inches of the intestine had been lost.

The stricture had strangulated the portion of intestine that had been discharged, and had occasioned a mortification in the upper part of the intus-suscepted portion; whilst, by exciting adhesive inflammation at the part, it had produced adhesion of the superior with the inferior portion, and, consequently, a continuity of canal.

Of the Mesentery.

This is the medium by which the smaller intestines are fixed to the body. It is a flat and broad membrane, composed of two layers of peritonæum, between which, the arteries, veins, nerves, and lacteal glands and lacteal vessels, and a small proportion of fat, are placed. This connecting membrane is expanded somewhat like a fan, being broader before than at its connection with the vertebræ, and is so much so, as to be connected with the whole of the jejunum and ileum, which always present a concave surface to it, and from being of great extent, it forms a number of plaits.

The intestines are fixed to the broad extremity of the mesentery, and being longer than it, have the appearance of being gathered or puckered to it. Owing to the above beautiful mechanical contrivance, their convolutions are kept in a certain relative position, and though very moveable, cannot be entangled or involved with each other or displaced, and at the same time are evidently less liable to be injured by external violence. The mesentery also serves to lodge, conduct and defend the arteries, veins, and nerves proper to the intestines, and also the lacteal vessels, which take their rise from the inner surface of the intestines.

It sometimes happens, that there are one or more processes of two or three inches in length, which are connected with the smaller intestines, and terminate in a blind end. We generally meet with only one such appendix, but I have seen a few examples of two or even three such appendices connected with the smaller intestines. These appendices are of a cylindrical form and have the same size and same coats as the other parts of the smaller intestines. It has been matter of much disputation, whether such appendices, which are found within herniæ, are more frequently an original formation, or were formed after the protrusion of the bowel. The latter of these opinions is to me the more probable. It is not easy to see how it should happen, that that particular portion of intestine having an appendix connected with it, should chance to get into the hernial sac. It is more probably formed, by the elongation of the adhering part of the intestine, within the hernial sac, which is the consequence of the vermicular action of the intestines. The adhering portion is thus extended into a cul de sac, and this happens more especially in crural hernia, in which the bowels pass through a narrow aperture with unyielding boundaries.

Of the Larger Intestines.

The larger intestines, which surround the smaller, extend from the caput cœcum coli to the anus, and are distinguished from the smaller by their size, form, situation, appendices, epiploicæ, connections, and functions. The situation of the

larger intestines is more constant and defined than that of the smaller intestines.

The caput cœcum coli is fixed down to the right os ilium by the peritonæum, which therefore may be opened from behind without exposing the cavity of the abdomen.

This operation may become necessary to save life, when extraneous bodies have been lodged for some time within this portion of intestine, and cannot be removed from it by external pressure. The appearances upon dissection, in a case in which a concretion had been lodged within the caput cœcum coli, (Vide Morbid Anatomy of Gullet, &c.), clearly pointed out the practicability of such an operation, and its absolute necessity to the preservation of life.

From the caput cœcum coli, the colon ascends before the right kidney; it then goes upwards and backwards under the liver, then passes across the body from right to left, under the stomach and spleen; with which it is connected by the omentum majus.

It descends on the left side of the abdomen, and before the left kidney, and then is incurvated, forming what has been called, from its resemblance to the sigma (σ) of the Greeks, its *Sigmoid Flexure*, which rests upon the left os ilium. It afterwards descends into the pelvis along the concave surface of the os sacrum, and ossa coccygis. This portion of the large intestine has commonly, but improperly, been called *intestinum rectum*, for it is by no means straight; but follows the same course as the bones, to which it is fixed by the peritonæum.

The lower extremity of the rectum forms the anus.

The larger intestines have been divided by anatomists into the caput cœcum coli, the ascending part of the colon; the left decending portion; the sigmoid flexure, and that part attached to the os sacrum, which has been named the rectum, although it should rather have been called *curvum*, as it describes a portion of the same curve as the os sacrum.

The colon is not of an equal size. The caput cœcum coli, situated on the right os ileum, is the most capacious portion

measures about four or five inches in diameter; and in graminivorous animals it is of still greater diameter.

This portion of the intestinal canal is extremely liable to disease. The food within the caput cœcum coli is out of its direct route, and is often arrested for a time in this situation. Extraneous bodies often stick in this part of the intestine, and prove a cause of the formation of alvine concretions. In the Museum of the University of Edinburgh, there is a large collection of these substances, of which I formerly published a full account *.

These concretions are various in point of size. Some are not larger than a garden-pea; but others are as large as an orange; and some attain a much greater bulk, weighing three or four pounds.

The smaller concretions are of a yellow colour, of an oval or rounded figure. The larger are more irregular, consisting of a number of lobes; and some of them seem to be composed of a congeries of smaller concretions, and are covered by a white crust, which seems to be deposited in successive layers.

There are commonly two or three concretions found within the human intestines; but sometimes a greater number.

Some alvine concretions are porous, somewhat like dried sponge, and composed of fibres intimately interwoven with each other.

Some of the concretions, when divided, exhibit lamellæ about two lines in thickness, and a central nucleus; but, in others, there is neither a nucleus nor lamellæ.

There are small cavities within some alvine concretions.

Since my account of these concretions was published, Dr Marcet examined with great attention one of these substances, which I gave to my pupil Dr Silveira, and has stated that the fibres which constitute the larger proportion of the concretion are those of the beard of the oat †.

In justice to Dr Davy's acumen, it is proper that I should state, that about a year, (viz. in 1812,) after Professor

* Vide Morbid Anatomy of the Gullet, &c.

† Marcet on Calculi, 2d edit. p. 139.

Thomas Thomson had analysed several of the alvine concretions, in the Museum of the University of Edinburgh, Dr Davy, at my particular request, examined several others, which Dr Thomson had not analysed previously, and at the time gave me a long report on the subject, which he concluded by the subjoined remarks.

"The most probable conjecture appears to me to be, that *they are produced from the remains of the ingesta during their stay in the large intestines.* Thus there would be no difficulty in accounting for the saline ingredients, all of which exist in the fæces, and it is easy to conceive that *the fibrous like the saline is derived from the food.*"

The lower part of the intestinum rectum or curvum, in point of capacity, is next to the caput cœcum, and intended as a receptacle for fæculent matter.

The larger intestines differ from the smaller in many particulars. The fatty papillæ, called *Appendices Pinguedinosæ*, attached externally to the large intestines, the adipose strata, the pouches of the colon, are peculiar to the larger intestines. By means of three ligamento-muscular bands, which take their origin from the appendix vermiformis, and are shorter than the colon; that bowel is contracted into a number of small rounded sacs. These three bands pass along the colon, nearly at equal distances. One of these is placed where the great omentum hangs from the colon; the second sweeps along the inferior portion of that bowel; and the third is concealed by the attachment of the mesocolon. These ligaments become gradually broader, and are at length expanded into an uniform stratum.

The larger intestines are fixed to the body by a duplicature of peritonæum, called *Mesocolon*, a part of which, from its situation on the right side of the body, has been called *Mesocolon dextrum;* and the part on the left side, the *Mesocolon sinistrum.*

The *Mesocolon dextrum* passes from the liver, and from the quadratus lumborum muscle of the right side, covering only the anterior part of the colon, and fixes it firmly down to the iliac muscle.

The second portion may be called the *Transverse Mesocolon.*

That on the left side, or third portion, called *Mesocolon sinistrum*, is continued over the left side of the colon, from the iliac vessels, and psoas magnus, to the left kidney, covering only the anterior surface of the colon, the back of which is connected, by cellular substance, with the diaphragm, the psoas muscle, and the kidney.

The rectum, which constitutes the lower portion of the larger intestine, has been enumerated among the contents of the pelvis. The bowels of the pelvis are united by means of the peritonæum, which may be traced from the recti muscles of the abdomen, to the under and back part of the bladder of urine, from which it is reflected upon the rectum, and then to the sacrum; and, in women, upon the upper part of the posterior surface of the vagina.

The peritonæum generally covers only the anterior and lateral portions of the rectum; but, in some cases, it surrounds the bowels forming its meso-rectum.

Owing to the loose connection between the bladder and rectum, it has often happened, when the lateral operation of lithotomy has been unskilfully performed upon the male, that the instruments, owing to the resistance of the prostate gland, have been passed into the sac between the rectum and bladder, instead of having reached the bladder; and, as they may be moved freely within that sac, the surgeon has not been aware of the error which he has committed.

The *Intestinum Rectum* follows the sweep of the os sacrum, inclining rather to the left side of that bone; and it has a special relation to the bladder of urine, and organs of generation of both sexes, and therefore merits peculiar attention.

Beyond the reflection of the peritonæum, the rectum is united, by cellular substance, to the vesiculæ seminales and prostate gland of the male; and, in the female, to the vagina.

The peritonæum is, in most instances, reflected from the rectum to the bladder of urine, about 3 inches from the verge of the anus, when the bladder has been distended.

There is much variety, in different subjects, as to the place where the peritonæum is reflected from the bladder upon the rectum; generally speaking, it is opposite to the posterior parts of the vesiculæ seminalis. This fact is well worthy of particular attention, because it is unsafe, in operating upon fistulæ, high up within the rectum, to divide that portion of the rectum which is beyond the reflected peritonæum; if the rectum shall be divided higher up, the cavity of the abdomen is opened, and the patient is exposed, not only to peritonæal inflammation, but also to the risk of bleeding from the internal hæmorrhoidal artery and vein. The same observations also apply to the cutting into the bladder of urine from the rectum.

This portion of the larger intestine is the receptacle in which the fæces are accumulated, before being expelled. It is constructed so as to admit of considerable distention. When this bowel is empty, there are several transverse folds, which disappear when it is distended.

About four or five inches from the verge of the anus, the rectum seems as if it had been begirt by a tight cord; and, opposite to that place, there is, in the adult, an obvious projection of the inner coats which encroach about a quarter of an inch into the rectum. The fæces are gradually collected within this bowel, which readily admits of distention; and, when accumulated within it, by their quantity, weight, and acrimony, the intestine is much stimulated to contraction. It may be proper to observe, that the length of time the fæces are retained, varies according to the quantity of the contents, and nature of bile, which has a great influence as to the evacuation of the fæces. The bowels of the young are much more irritable than those of the old and infirm. Food passes through the bowels generally in 24 hours.

By the diaphragm and abdominal muscles, we strain, in order to compress the rectum, to overcome the resistance of its sphincter, and expel the contents.

The *Levatores ani*, which form the lower part of the pelvis, are the antagonists of the diaphragm: they support the rectum; prevent it from yielding too much; and, upon the anus being sufficiently opened, the contents of the bowels are pro-

truded by the contraction of its muscular fibres; after which the rectum is retracted by a different portion of the levator ani and transversalis perinæi, and by the longitudinal fibres of the rectum; and the anus is shut by its sphincter muscle.

Dr Paley makes the following excellent observations on the sphincters. "The regulated degree of contractile force with which they are endowed, sufficient for retention, yet vincible when requisite, together with their ordinary state of actual contraction, by means of which their dependence upon the will is not constant but occasional, gives them a constitution, of which the convenience is inestimable. This semi-voluntary character is exactly such as suits with the wants and functions of the animal *."

Every part of the rectum is not equally distensible: that part of it which is behind the sphincter ani, may be extended into a considerable sac, in the transverse direction. This sac is only obvious in the adult, being formed by the retention and accumulation of the fæces. This is very conducive to our convenience, Thus we are enabled to choose a fit time and place for discharging the contents of the rectum: But if the individual does not obey the warning, and the fæces are accumulated, the muscles act involuntarily, and expel the fæces. The lower end of the rectum is somewhat contracted, serving to assist the sphincter ani in retaining the fæces. The rectum, at its lower extremity, is surrounded by fat cellular substance and mucous follicles.

The particular direction of the intestinum rectum should be remembered by the surgeon, while he is introducing a clyster-pipe, otherwise the patient may be materially hurt; and, at the same time, the form of the pipe should be accaccommodated to that of the rectum, and also by its mesorectum.

The rectum is fixed down in its situation, by the peritonæum, which is reflected from the upper and back part of the bladder of urine.

* A more particular account of the muscles of the anus will be given under the head Muscles of the Organs of Generation.

Of the Coats of the Smaller Intestines.

The intestines have four coats, a *Peritonæal*, *Muscular*, *Cellular*, and *Villous* coat.

It is still undetermined, whether the intestines have a cuticular lining or not. I have often looked for it with great care, both in the human body, and in the inferior animals. It is possible it may, on account of its extreme thinness, have eluded my research. Morbid anatomy presents a strong argument in favour of the existence of such a cuticular lining. The different textures of the body are liable to peculiar organic derangements. Warts have been enumerated amongst the organic derangements of the cuticle; and, in the camp dysentery, it is not uncommon to find a portion of the villous coat of the intestines covered with a great number of small brown warts.

Peritonæal Coat.

The outer coat is derived from the peritonæum. Its external surface is quite smooth, and lubricated, like other serous membranes, by a thin serous fluid. This coat possesses considerable toughness and elasticity, and serves to strengthen the intestines.

Muscular Coat.

The second coat is composed of muscular fibres, disposed in a longitudinal and circular manner.

The former are very thin and pale, and visible only on the convex surface of the intestine; whereas the latter, or the circular fibres, are much coarser, and more apparent, especially in the duodenum; but they are not so obvious in the jejunum and ileum. Upon examining minutely each circular fibre, it may be observed to be made up of several distinct segments of circles.

The above description applies to the greater share of the intestinal canal, but in the intestinum rectum, or rather curvum, the stratum of longitudinal muscular fibres is very obvious, the fibres being thick and strong.

The longitudinal muscular fibres shorten the canal, and the circular fibres diminish its caliber, and in a very complete manner, so as to push on air or quicksilver.

The intestines of a living animal are alternately distended and contracted, or move, in different directions, somewhat like a worm crawling along the ground, or perform what is called in the technical language, the *peristaltic and antiperistaltic movements.*

The peristaltic movement is not continued regularly from the top to the bottom of the intestinal tube, but begins at once in several different portions of it.

When the food comes into contact with a portion of intestine, that portion immediately contracts itself, forming a fixed point, towards which the portions above and below are drawn, by means of the longitudinal fibres, which shorten the canal, and, at the same time, dilate the under part.

The antiperistaltic action is exactly the reverse of the above, and by it the food is turned over and over, and exposed to the orifices of the lacteal vessels. Should the free progress of the aliment be interrupted by this inverted action, the contents of the intestines are rejected by vomiting. The rapidity with which the peristaltic and antiperistaltic motions take place varies considerably, depending on the degree of excitement, and sensibility of the intestine.

A mixed action has been described, which partakes of the peristaltic and antiperistaltic action.

The peristaltic and antiperistaltic motions of the intestines are completely involuntary; they can neither be stopped nor accelerated, at pleasure. The muscular fibres, like the other muscles, may be said to be under the influence of the particular stimulus of the chyme and bile. They are excited to an inordinate action by purgatives, cold, or other extraneous bodies, and even by passions of the mind.

Cellular Coat.

The third coat of the intestines is the cellular coat, which is the bond of union between the muscular and villous coats.

Anatomists are by no means agreed as to the structure of the cellular coat or cellular substance.

I am disposed to deny the existence of cells in the cellular substance of any part of the body; and to say that these are artificially formed, by blowing air, or throwing an injection into this peculiar texture; and that during life, this is a soft slimy tenacious substance, the constituent parts of which are disjoined, by the air thrown into it.

Villous Coat.

The villous coat is connected by a loose band of cellular substance to the muscular coat.

It is much more extensive than the other coats, and forms those doublings called *Valvulæ Conniventes*, improperly; for they do not perform, with accuracy, the office of valves.

These doublings are placed transversely in the jejunum, but in the duodenum and ileum they are disposed longitudinally: in the ileum they become gradually very small, and almost disappear in the end of it.

These valvulæ conniventes very rarely extend through the whole circle of the intestine; often they are joined by communicating folds.

These valves are broadest in the middle, and narrower at the extremities. In general they are about a line and a half broad. One edge of these valves is loose, but the other is fixed to the intestine.

The valvulæ conniventes of different animals vary considerably as to form, and in some are awanting.

The villous coat is a mucous membrane, covered with villi, which vary in length in different animals: after filling the bloodvessels, by a good injection, these villi seem to be made up of a network of bloodvessels, nerves, and orifices of the mucous ducts and lacteal vessels.

The coats of the larger intestines are nearly alike to those of the smaller intestines, excepting as to the ligamento-muscular bands, which take their origin from the appendix vermiformis, and have been already noticed.

The liquor of the intestines, called *Liquor Entericus*, is

derived from the ramifications of the arteries which are proper to the villous coat.

The nerves, proper to the intestines, are very minute. According to some, the intestines are not under the power of volition; they are only the medium by which other stimuli are conveyed.

Of the Mucous Glands of the Intestines.

The mucous glands of the intestines are more or less obvious, being of different sizes in different animals. They are of a rounded or oval form, and are imbedded within the cellular coat of the intestines, and their ducts perforate the internal coat. They are numerous in the smaller intestines, especially in that part of the duodenum which is next the stomach, and are collected into groups or are solitary, and are also observed at the caput cœcum coli, in clusters.

There are also a considerable number of mucous glands in the vicinity of the anus. These glands are of a very simple structure: they consist only of a small cavity, upon which small bloodvessels are distributed, and from that cavity there is a small duct, which opens into the cavity of the intestine.

These glands are often considerably enlarged by disease, and when in that state, have been very faithfully represented by Rœderer, in his treatise *De Morbo Mucoso.*

Of the Coats of the Rectum.

There are four coats proper to this portion of the larger intestines, a peritonæal coat, a muscular coat, a cellular and a villous coat. The muscular fibres of this portion of intestine, which follow a longitudinal direction, are more apparent than in any part of the intestines, and especially those longitudinal fibres which are placed in the front and in the back part of this bowel. The circular fibres near to the anus acquire a considerable degree of thickness and redness, and form, according to some authors, the *sphincter ani internus.*

The mucous coat of the rectum is also thicker, redder, and has more of a velvety surface than in any other part of the

intestines; and there is a ring around the lower extremity of the rectum, which consists of deep cavities, separated from each other by ridges; or there is a glandular appearance at this place, which may be constantly observed.

The rectum is also largely supplied with blood, by the inferior mesenteric, and internal hæmorrhoidal arteries, as there is a necessity for a large secretion of mucus for the defence of the rectum against the acrimony of its contents. The veins of the rectum are large and numerous.

In consequence of the straining at stool, the veins of the rectum are frequently so much compressed and distended, as to occasion the formation of piles: these piles are often removed by the daily use of laxative medicines, which render such straining of the muscular fibres of the rectum, in expelling its contents unnecessary.

Malconformation of the rectum is by no means very uncommon. In the "Morbid Anatomy of the Gullet, Stomach, and Intestines," I have published various instances in which the external aperture was awanting.

From what has been stated as to the structure of the several coats of the intestines, it follows, that the bowels must be liable to several organic derangements, independently of those connected with a displacement of particular portions of the intestines.

They are liable to those kinds of inflammation which are peculiar to serous and mucous membranes, and to the muscular fibre. As there is a considerable quantity of cellular substance between the muscular and villous coats of the intestine, and especially around the verge of the anus, pus is often formed in it; and in the case of the rectum, by bursting inwardly or outwardly, or in both directions, fistulous orifices are formed.

The alimentary canal is liable to constriction, by the organic derangements of its different constituent coats, or by organic derangements originating in the glands proper to it.

The stricture is temporary or permanent; the former originating from a spasmodic contraction of the muscular coat, the latter from a permanent organic derangement of some part of the alimentary canal.

It seems not improbable, that these very opposite causes of stricture may be occasionally combined; as all patients who labour under a permanent obstruction, suffer occasionally from a considerable aggravation of the symptoms.

Besides those strictures occasioned by a thickening of the valvulæ conniventes, or by tumours of different descriptions growing from the villous coats, or by extraneous bodies lodged within the alimentary canal, and by pus lodged within the cellular coat, there are two kinds of stricture, in which all the coats are more or less affected, thickened, and indurated.

The first may be called the inflammatory; the second, the cartilaginous, or scirrhous stricture.

The first is met with at all periods of life; is often the immediate consequence of acrid substances being swallowed, of concretions, of dysentery, and of external violence; and it appears in a short time after the violence has been inflicted. We meet with strictures of this description in the urethra, after repeated attacks of gonorrhœa, and in the biliary ducts, from the irritation of gall-stones.

Upon dissection, we observe a thickening of all the coats, especially of the muscular coats, at the seat of the stricture; an effusion of coagulable lymph between them: the bloodvessels at the seat of the stricture, which were much enlarged and distended by blood, form a net-work upon it; and there is also a quantity of turbid serum effused into the cavity of the abdomen, when the disease is seated in the intestines.

The second, or scirrhous stricture, is of slow growth; appears only in persons who are far advanced in life, of a sallow complexion, and who are disposed to cancer; or in those whose constitutions have been much impaired: upon dissection, we meet with a constriction, of an inch in length, of a cartilaginous consistence, and in which there is no appearance of the coats of the alimentary canal; all of these having been absorbed, and cartilaginous matter deposited in their stead. This species of constriction generally terminates in the cancerous ulceration. It is very easy to discover the seat of the stricture; for that part of the alimentary canal which is above the stricture is much enlarged; whereas that beneath it is much contracted; and by tracing either of the

dilated or contracted portions, we soon discover a part of the canal which seems much contracted, as by a cord having been put around it, and which had left a purple mark: upon pressing this part, it feels heavy and hard.

Strictures generally take place at that part of the canal which is naturally most contracted.

The part above the stricture is much extended, often inflamed, ulcerated, and sometimes eroded.

Of Chylification, or of the changes which the Food undergoes within the Duodenum.

The food within the intestines is changed into an excrementitious and useless part; and into a chylous or nutritive fluid; which latter is absorbed by the lacteal vessels.

Though the duodenum at first sight be similar in structure to the other smaller intestines, yet there is reason to suppose, that the alimentary mass is longer detained in the duodenum than in the jesunum or ilium; as it is much more capacious, more curved, and provided with a greater number of valvulæ conniventes.

The assimilation of the alimentary mass within the duodenum is promoted by the addition of the *bile* and *pancreatic juice*, by which acids, taken in along with our food, or generated by a morbid state of the stomach, are blunted, and probably neutralised.

The effect of the acid matter upon the aliment, is thus counteracted; for, when bile is mixed with any acid, the acidity takes off the bitterness of the bile, and the bitterness of the bile takes off the acidity, and may perhaps bring about the separation of the chyme into chyle and excrementitious matter.

The bile is probably separated into two parts within the duodenum, viz. into the albuminous part, which flows into the blood along with the chyle, and into another part, which communicates its colour and bitterness to the excrement, and which serves, at the same time, to stimulate the intestinal canal.

On opening the smaller intestines, we meet with a mucous

and gelatinous fluid, mixed with their contents, and sometimes a white, and at other times a yellow fluid besmearing the villous coat, which, in a healthy man, may be readily distinguished from the alimentary mass.

According to MAJENDIE, different kinds of chyle are found within the intestines. The same author has also stated, that he had an opportunity of examining the bodies of two criminals who had taken nearly the same kind of food, and in the same quantity; he found the chyme in the pyloric portion of the stomach and in the small intestines exactly similar in all respects.

The excrementitious part of the alimentary mass is found within the larger intestines, which, being very capacious, serve as a reservoir, within which the fæces are collected, in order to preclude the necessity of their constant evacuation.

On account of the great capacity of the larger intestines of some animals, it seems probable that the alimentary mass undergoes within these some great and important change, especially in the horse, in which animal they are much more capacious than the stomach.

The larger intestines are filled by a yellow feculent substance, which, according to BERZELIUS, is composed of

Water, - - - - -	73.3
Vegetable and animal remains, -	7.0
Bile, - - - - -	0.9
Albumen, - - - -	0.9
Peculiar extractive matter, - -	2.7
Slimy matter, containing resin of the bile, peculiar animal matter, and insoluble residue, -	14.0
	100.0

It has been supposed, that the meconium of new born infants is pure bile. Dr BOUILON LAGRANGE (in the 259th number of the Annales de Chimie), has stated, that it contains water, hairs, a matter similar to the mucus of the nose; and a proportion of a substance which may be regarded as pure meconium, and which bears a stronger resemblance to an animal

than a vegetable substance; and that it does not contain bile, as had been imagined.

The air found within the smaller intestines differs from that of the larger. According to MAJENDIE and CHEVREUL, pure hydrogen predominates in the former; and in the latter, there is only carburetted and sulphuretted hydrogen.

Lastly, as the greater number of lacteal vessels take their rise from the smaller intestines, as life may be continued (as we see in the case of an artificial anus at the groin) though the alimentary mass does not pass through the larger intestines, and can he prolonged but for a few weeks by nutritious clysters, it is evident, that the smaller intestines constitute the most essential part of the intestinal tube.

CHAP. IV.

ON THE ORGANS WHICH ASSIST IN CHYMIFICATION AND CHYLIFICATION.

SECT. I.

OF THE LIVER OF THE ADULT.

THE liver of those animals that are provided with a heart and bloodvessels, is a conglomerate gland, of a considerable size. The human liver is by no means of an uniform size in the male and female, or at every period of life; for in the male it is rather larger than in the female, and in infants it is proportionally larger than in adults.

The liver is by no means of an uniform size, even in persons who have enjoyed the most perfect health, being in the

active and robust always smaller than in the sedentary and luxurious;—an observation which also holds true with regard to the inferior animals. The liver of birds that are domesticated has been remarked by Robinson, to be larger than that of the same species of birds, in their wild state.

In quadrupeds the liver is proportionally larger than in man, and divided into a greater number of lobes; and in fishes and mollusca it is proportionally still larger.

Generally speaking, the weight of the human liver, of a healthy man, between 20 and 30 years of age, is equal to 3 lb. or 4 lb. Troy. In consequence of disease, I have seen it weigh 20 lb. or 25 lb.; and, on the other hand, it sometimes does not weigh as many ounces. It is impossible, by mere inspection, to form a correct estimate of the weight of the liver; for there are some organic derangements which render the liver of a more compact texture, and there are others which have a contrary effect.

Of the Situation of the Liver.

The liver is contained within, and defended by the ribs, and their connecting cartilages; it ascends within the chest, so as to be opposite to the fifth true rib; and descends in front, so as to project about an inch below the cartilago ensiformis of the breast-bone.

The right lobe of the liver is placed obliquely in the right hypochondriac region, and is rather lower than the left lobe, which is placed horizontally, and occupies the epigastric region and a part of the left hypochondriac region.

Much pains have been taken by anatomists, and especially by Portal, to discover the exact position of the liver, in respect to the contiguous parts; but I doubt whether such an accurate knowledge as he wished, can be gained, by examining the dead body; because the bowels of the abdomen, during life, mutually support each other, and all of them are supported by their parietes; whereas, by a general relaxation of the ligaments, and yielding of the parts after death, the liver is not supported, and falls down lower than during life.

Even during life, the position of the liver undergoes a most

material change: during a full inspiration, descending more than an inch, and to a still greater degree, in consequence of a collection of purulent matter, water or air, within the chest: on the other hand, during the last months of pregnancy, or by dropsy of the belly, it encroaches considerably on the cavity of the chest, ascending, in some instances, as high as opposite to the fourth rib; and when the stomach and colon have been considerably distended, the liver is pressed considerably upwards, and especially the anterior part of it, so that the position of that organ is considerably changed.

The liver bears the following relation to the neighbouring parts.

The upper convex surface of it is adapted to, and in contact with, the diaphragm. The under irregular surface rests on the right kidney, the stomach, omentum majus, arch of the colon, and duodenum; and the posterior rounded surface is opposed to the crura of the diaphragm and lumbar vertebræ. The right lobe is in contact with the pylorus and colon, and lies over the right kidney. The left lobe is placed horizontally, and lies over a part of the stomach.

The situation of the liver, in respect to the neighbouring parts, merits attention, as enabling the practitioner to form an opinion as to the effects which result from the increased bulk of that organ, and also as to the different channels by which purulent matter may find an exit from the liver.

The pressure of the enlarged liver may interrupt the functions of the stomach; or the same cause, impeding the free circulation of the blood through the different bowels of the belly, as well as through the liver itself, may produce a dropsy of the belly.

The enlarged liver is the source of still farther mischief; by pressing upon the gall-ducts, it impedes the free passage of the bile into the intestinal canal, and the bile thus obstructed passes off by another channel, and is taken up by the lymphatic vessels, occasioning jaundice.

Nor is this all the evil to be apprehended from the affection we are considering. By means of inflammation the enlarged liver may be united to the neighbouring parts, and if

in such a situation an abscess should take place within it, the contents of that abscess might be discharged into the general cavity of the belly, into the sacs of the pleuræ, or even into the lungs, or into the stomach, duodenum, or colon, or they may be discharged externally.

Though the term *liver-coloured* be employed in common language, yet no very definite idea is affixed to the word; few persons agree perfectly in their ideas on this subject.

An accurate idea of the colour of the healthy liver can only be gained by inspection of the liver immediately after death, and whilst the body is warm. Authors differ very much in their descriptions of the colour of the healthy liver; some have described it as being like old mahogany in colour, but there are infinite varieties as to the colour of this wood. Others have described it as being of a mottled colour, yellow and red. The engraving, which I published from the liver of a criminal whose body was opened about an hour after death, represents the liver of a deep pink colour.

The liver has always been described as varying in colour, according to the quantity of blood contained within its vessels; but there is little difference as to the colour of the liver of an animal killed by suspension, and of one that has been bled to death. The liver of the dog is not of the same colour as the human liver; it is much more of the purple hue. I have examined with considerable attention the livers of several animals immediately after they had been killed, and have invariably remarked, that they were of a darker purple colour than the human liver.

Of the Coats of the Liver.

The liver has two coats. The outer is derived from the peritonæum; it is very thin, transparent, easily torn, and vascular, and is lubricated by a serous fluid, which gives it a shining surface. It does not cover the posterior part of the liver, nor the excavation for the gall-bladder, vena cava, nor the fissures in the concave surface of the liver.

The internal surface of the peritoneal coat is irregular, and is intimately attached to the proper coat of the liver, which

not only covers the surface of that organ, but also enters into its substance; and, on making a section of the liver, may be seen passing around the trunk and branches of the vena portarum.

Under the outer covering of the liver there is a small quantity of cellular substance, especially at the upper part of the right lobe, in which the trunks of the lymphatic vessels of the liver are situated, and also in the sinus of the vena portæ, which is a bond of union between the vena portæ, the biliary ducts, nerves of the liver, and hepatic artery.

The proper coat of the liver is thin: though nearly transparent, it is not easily torn, and it covers not only every part of the surface of the liver, but also the large vessels which are proper to this organ. The discovery of this membrane has been claimed by the modern French anatomists; but such a claim is by no means just; for this membrane was described by Mr Grieve, in his thesis De Secretione Bilis, which was published in 1731.

Of the Ligaments of the Liver.

The position of the liver is, to a certain degree, only regulated by the reflections of the peritonæum, called *Ligaments*, though they do not, in structure, bear an exact analogy to the ligaments which fix the bones to each other. The uppermost ligament is formed by a reflection of the peritonæum passing from the diaphragm to the liver. It is fixed obliquely to the diaphragm, and to the extremity of the ensiform cartilage of the breast-bone, and adheres to the sheath of the rectus muscle, as far as the navel. This ligament is double, or consists of two layers of peritonæum, between which there is a small quantity of cellular membrane, and a few lymphatic vessels, which pass from the upper and convex part of the liver to the chest. This ligament, when stretched, bears some resemblance to a sickle, and has been hence called the *Falciform Ligament*, and by others the *Suspensory Ligament* of the liver, from its supposed office of supporting the liver. But this ligament has little or no effect in suspending or supporting this bowel, which is rather supported by the contiguous bowels than by

the reflected peritonæum; in proof of which, the liver changes its place during inspiration, descending for nearly two inches, or when we lie on the side. On lying on the right side, the liver is supported by the cartilages of the ribs; but, when we turn to the left, the stomach is compressed by the weight of the liver; hence we do not sleep so soundly on the left as on the right side. It seems to me, that the omentum hepato-gastricum, vena portæ, and vena cava, may contribute more to the retaining of the liver in its place, than the falciform ligament. This ligament may be readily seen, by making an incision from the ensiform cartilage downwards, on each side of the recti muscles of the abdomen, and by turning them upwards. This ligament is thin and transparent, excepting at its under part, and extends backwards from the sheath of the recti muscles. In the under part of the falciform ligament, the shrivelled umbilical vein of the fœtus, which is generally, though not always, quite impervious in the adult, is placed.

The right and left lobes of the liver are united to the corresponding portions of the diaphragm, by the reflections of the peritonæum, which hence have been called the *Lateral Ligaments*, which are evidently the continuation of the falciform ligament. Besides the above reflections of the peritonæum, there is a portion of this membrane which extends between the liver and right kidney, and which has been named by Haller, the *Ligamentum Hepato-Renale.*

The above author has also described a portion of the peritonæum, which extends from between the liver and the gall-bladder, across the duodenum, to the colon, under the name of *Ligamentum Hepato-Colicum.*

The *Coronary or Posterior Ligament* of the liver is of considerable breadth, and serves to connect the middle of the posterior surface of the liver to the middle tendon of the diaphragm.

The *Falciform Ligament* is placed on the fore-part of the coronary ligament, and the lateral ligaments at the side of it.

The human liver is an organ, of considerable thickness, and unequally so, being thickest behind, and on its right ride. Its transverse diameter is greater than the anteo-posterior

diameter; in shape it is somewhat like the hoof of the ox, being rounded above, and split into two great lobes, and concave below.

The upper surface of the liver is not precisely convex; it is contiguous to the diaphragm, and is on the left side slightly impressed by the apex of the heart, to which it is opposed.

The upper and back part of the liver is thick and rounded, where it is fixed by the reflected peritonæum to the diaphragm; and it becomes gradually thinner from right to left, and also towards its fore-part, which has been called its *Edge*, which, in the right lobe, is directed obliquely downwards, but in the left lobe is nearly horizontal.

The inferior surface is not so extensive as the upper convex surface; it is irregularly concave, and inclines a little upwards and backwards.

The upper convex surface of the liver is divided into two great lobes of unequal size, by means of the falciform ligament; and the under concave surface is divided into two parts by the fossa umbilicalis.

The right lobe is generally much larger than the left; but there are many exceptions to this, even when the liver is sound; and disease produces a great change not only in the colour, bulk and texture of the several parts of this organ, but also in the relative proportions of the several component parts.

The concave surface of the liver, which rests on the stomach and intestines, is very irregular, and is compressed by the contiguous bowels.

There is a remarkable prominence on the under surface of the liver, which inclines downwards, and towards the right side, from its posterior thickened part. The figure of this projection is somewhat like that of the tongue, but it is considerably thicker towards its base than its apex. It has been called the *third lobe*, or Lobule of Spigelius. This lobule rests on the vertebræ, between the vena cava and gullet; and is placed behind the omentum hepatogastricum.

A rounded part of the liver passes between the gall-bladder and passage for the umbilical ligament, downwards from the lobe of SPIGELIUS to the right lobe, serving to connect it to the right lobe, which bearing a distant resemblance to the tail of an animal, has been named the *Processus caudatus* of the liver by HALLER.

A part of the under surface of the right lobe of the liver, situated between the gall-bladder and round ligament, is somewhat of a square figure, or of the form of a parallelogram; and on account of its shape, has been named the *Lobulus quadratus*, or *Lobulus anonymus* of HALLER. There are several depressions, of different breadths and depths, in the concave part of the liver.

There is a considerable notch in the anterior edge of the liver, which marks the beginning of the fossa umbilicalis. This fossa extends from the front to the back part of the liver, dividing it into two lobes. It is frequently covered over by a portion of the liver.

This canal lodges the umbilical vein in the fœtus, which, in the adult, is generally impervious.

There is another fissure in the liver, which occupies nearly the middle part of its lower surface: it is neither so deep nor so long as the preceding, and it is placed transversely, or in the long diameter of the liver, and has commonly been called the *Sulcus transversus:* it is bounded at its extremities by the right and left lobes, behind by the lobule of SPIGELIUS, and before by the lobulus caudatus.

In the transverse fossa are contained the trunk of the vena portæ, called Sinus, and its two great branches, the hepatic artery, the common biliary duct, lymphatic glands, lymphatic vessels and nerves. These are united by condensed cellular substance, and which has been described by GLISSON as a capsule.

Between the great left and third lobes, there is also a short fossa, which lodges the ductus venosus, and which passes obliquely from right to left between the sulcus transversus and vena cava.

There is also a deep short canal, which lodges the vena cava, between the right lobe and the third lobe.

Of the Bloodvessels of the Liver.

The liver receives blood from two very different sources, viz. from the vena portarum and the hepatic artery. The vena portæ is a large vessel formed by the conjoined gastric, superior mesenteric and inferior mesenteric veins; but though formed by these large veins, it performs the office of an artery, and, like an artery, divides into small branches, and has coats which in thickness resemble an artery, though it has no pulsation. It is situated in the great transverse fissure of the liver, where, on account of its great size, it has been called Sinus venæ portæ. The branches of this vessel accompany those of the hepatic artery, and ultimately are distributed on the acini of the liver.

The hepatic, a branch of the cœliac artery, divides very minutely through the substance of the liver, and also sends branches to the external coat of that organ. The minuter branches of this artery are disposed somewhat like the hairs of a painter's brush, and hence these have been called the penicelli of the liver. This particular distribution of vessels will be seen in the liver of the cat.

The blood conveyed to the liver by the vena portarum and hepatic artery, is returned to the heart by the large veins called venæ cavæ hepaticæ, which unite with the branches of the vena portarum and hepatic artery; and, at the root of the liver, are conjoined with the vena cava, where it is about to pass through the diaphragm; and a few of the small branches of the hepatic veins terminate in the vena cava, where it lies behind the liver.

Of the Source of the Bile.

The bile has been commonly stated to be secreted from venous blood, which is of a dark colour; whereas all the other secreted fluids are derived from the florid arterial blood.

It has been disputed whether or not *Follicles* be interposed between the extreme branches of the hepatic artery and vena portarum, and the origins of the biliary ducts; and also, whether all the bile be derived from the vena portarum, or from the hepatic artery. My Father, who had devoted much attention to the structure of glands, and who had made many microscopical observations upon these, after filling, with great success, the biliary ducts, was of opinion, that the acini of the liver are *solely made up of cylindrical vessels.*

That the bile is formed by the vena portarum, is no doubt probable, from the very circumstance of an additional vessel being proper to the liver; as well as *from the large size of that vessel*, which is capable of containing four times as much blood as the hepatic artery: besides, its branches are distributed over every part of the liver, like those of an artery, and communicate with those of the hepatic duct.

The hepatic artery alone has commonly been stated by authors to nourish the liver. But there are several objections to such an opinion.

1*st*, Because the vena portæ of the fœtus in utero receives nutritious matter, and also probably oxygen gas, by the medium of the placenta of the mother.

2*dly*, My Father found, that, after throwing a ligature around the hepatic artery of a living animal, and then cutting it, there was an adhesion formed betwixt the liver and the side, which adhesion was supplied *with blood from the vena portarum.* Hence the branches of the vena portarum contribute to the nutrition of the liver, in the same manner as those of the pulmonary artery contribute to the nutrition of the lungs, as appears from a preternatural adhesion between the pleura costalis and pulmonalis being supplied with blood by the small branches of the pulmonary artery.

My Father, who had always entertained the above opinion respecting the hepatic artery, endeavoured to prove it, by diverting the blood of an animal from the vena portarum; but his experiment proved fatal in so short a time that no inference could be drawn from it.

Mr Abernethy met with an instance in which the trunk of the vena portæ terminated in the vena cava; notwithstanding which, bile was found in the biliary ducts, which could have been derived only from the hepatic artery.

The late Mr Wilson, Teacher of Anatomy in London, informed me of a case in which, on account of the very unusual distribution of the bloodvessels of the liver, there was reason to suppose that the greater part of the bile had been derived from the hepatic artery. The patient, a female of thirteen years of age, died from the effects of an injury of the head. On dissection, Mr Wilson found a large swelling at the root of the mesentery, consisting of several absorbing glands in a scrofulous state. Upon cutting into the mass, he accidentally observed a large vein passing directly from it into the vena cava inferior, which, on dissection, proved to be the vena portarum; and, on tracing the vessels entering into it, one was found to be the inferior mesenteric vein; and another, which came directly to meet it from behind the stomach, proved to be a branch of the splenic vein, but somewhat larger, which ran upwards by the side of the vena cava inferior, and entered that vein immediately before it became nearly surrounded by the liver. Mr Wilson then traced the branches of the trunk of the vessel corresponding to the vena portarum, sufficiently far in the mesentery and mesocolon, to be convinced that it was the only vessel which returned the blood from the small intestines, and the cœcum and colon of the large. He could trace no vein passing into the liver at the cavity of the porta; but a small vein descended from the little epiploon, and soon joined one of the larger branches of the splenic vein. The remains of the umbilical vein were impervious, and he traced the cord formed by them to the entrance of the portæ. The right lobe of the liver was small, in comparison to the size of the child's body, but the left lobe was larger, and of a roundish shape. The hepatic artery came off in a distinct trunk from the aorta, and ran directly to the liver. The cœliac artery came from the aorta, and divided into three branches; but the one corresponding to what is usually the hepatic supplied the stomach, and

part of the duodenum as usual, but did not go to the liver. *The hepatic artery was much larger than it usually is found to be*, and entered the liver as it usually does. The gall-bladder had nothing remarkable in its appearance: its size was in proportion to that of the liver, and it contained rather more than half an ounce of a bright yellow fluid similar to the bile: it was not however submitted to any other test but that of sight. The ductus communis choledochus was formed as usual, and entered the duodenum at the usual place. The spleen was small, hard, and had scrophulous tubercles on its surface. The lungs had some tubercles, but not in a state of ulceration. The heart was sound.

The body of the girl was rather emaciated, but not more than it might have been expected to have been, from the strongly marked scrofulous habit. Pus was found in large quantities between the dura and pia mater, which accounted for her death. Messrs MAINWARING and JONES of the Strand, had often attended the girl during several years of her life, and had perceived nothing remarkable in her powers of digestion, nor did they recollect any thing, after this structure was discovered, different from what was usually met with in other scrofulous children.

The bile is always secreted in greater abundance after a meal. This I learnt from a case I attended, in which there was an abscess in the liver, and a preternatural communication between the liver and lungs, through which all the bile flowed, and was discharged by coughing; in proof of which the fæces were of the same whitish colour, and had as little smell, as those of a person deeply jaundiced.

The quantity of bile discharged by coughing was different at different times. It was *always greater after meals*, and especially for an hour or two after dinner. The quantity expectorated could not be measured with great accuracy, from being mixed with mucus and saliva. The whole quantity in twenty-four hours was from ten to fifteen ounces; and, in this case, I had an opportunity of observing the effects of certain articles of food, and in particular of acids, as wine, and of different fruits, in increasing the quantity of bile.

Of the Internal Organization of the Liver.

The liver is of a very different texture from any of the other glands of the human body, and is more easily torn, in consequence of external violence. I have met with three instances of rupture of the liver, which had been occasioned by external violence. The patients survived but a few hours, and died from the great loss of blood. On tearing the substance of the liver, or on pressing a portion of it between the fingers, a number of small hard bodies, called *Acini*, are perceptible to the touch, which are of a lighter red colour than the rest of the liver; and these are united to each other by cellular substance. The form and size of these acini, which are the sources from which the biliary ducts take their origin, vary in different animals. Those of the human body are about the size of a millet-seed.

Ruysch has supposed that they are made up of a plexus of very minute vessels; and, on the other hand, Malpighi has affirmed that they are hollow, of which, however, he has not given any distinct evidence.

I have seen five or six examples of a very peculiar disease, by which the acini of the liver are rendered very conspicuous, in consequence of having attained an unnatural size, of which Plate I. conveys a more distinct idea than language can communicate.

Since the above was written, Dr Brewster has been so polite as to examine the liver by his microscope, and has favoured me with the subjoined remarks.

"The liver (of a lamb) seems to be composed of two different substances, the one being whiter than the other. The darkest portions seem most transparent, and appear to consist of minuter particles than the other parts. The bloodvessels seem to run almost always through the whiter portions.

"These two substances seem to have no organised structure, but to resemble a *coagulum* of particles.

"When a fresh piece of liver is squeezed between two plates of glass, part of it is pressed, as it were, into a fluid, in which the particles are seen floating.

"When a portion of the liver is dried, the fluid escapes, the surface being always covered with it like dew, as if it were a sort of oily or fatty fluid. One of the substances hardens or contracts more than the other, as appears from the dimpled aspect of the surface when drying.

"The liver is covered with a fine transparent and tough membrane."

We are not yet intimately acquainted with the chemical analysis of the liver. It does not readily putrefy.

According to BRACONNET, 100 parts of the parenchyma of the liver, consist of

Water,	68.64
Dry Albumen,	20.19
Phosphoret Oil,	6.07
A substance peu-azotée,	0.10
Chlorure of Potassium,	0.64
What he calls Sel Organique,	0.10
Phosphate de chaux ferrugineux,	0.47 *.

By drying, it loses considerably of its weight.

When a section of the liver is made, it seems to be a porous substance. The branches of the vena portarum may be observed, in a collapsed state, accompanied by those of the hepatic artery, and those of the duct. These adhere to the substance of the liver, by the medium of a gelatinous substance and cellular substance, in which the branches of the vena portæ and hepatic artery are lodged; and the branches of the vena portæ hepaticæ may be observed converging towards the posterior surface of the liver.

Every part of the liver is not necessary to life; and, notwithstanding the number and size of the bloodvessels proper to this organ, I have found that I could cut off one of the lobes of the liver, without killing the animal. The abdomen of a living rabbit was laid open, and one of the lobes of the liver was cut off. The animal did not express much pain during the operation. At first there was a profuse bleeding from

* Dict. de Med., tom. ix. p. 189. Paris, 1824.

the divided vessels of the liver; but, by pressure, it stopped in the course of 3 or 4 minutes. The incision in the abdominal parietes was carefully sewed up. For a few hours after the experiment, the animal seemed uneasy; but, after that period, it took its food as before.

I kept it for five weeks, during which period it seemed in perfect health; its digestion was not impaired, and its stools were of the usual colour, quantity, and consistence.

A similar experiment was made upon another rabbit, and with a similar result. I kept this animal upwards of 12 weeks. Upon examining the abdomen, the cut portion of the liver was found firmly glued to the parietes of the abdomen, by means of coagulable lymph.

Disease also demonstrates that every part of the liver is not essential to the functions of the animal economy. Thus we occasionally meet with large abscesses in the liver; and, upon their contents being discharged, some patients have for years enjoyed a tolerable degree of health. In the same manner, those worms called *Hydatids*, have been found, upon dissection, to fill a considerable portion of the right lobe of the liver, where, during life, no one symptom had occurred which led to a suspicion of their existence. Amongst several such instances which have fallen under my own notice, the following case is a striking illustration of what has been alleged.

A dragoon, a stout active and robust young man, to all appearance in the most perfect health, betted that he would drink a number of glasses of whisky in a given time. He did so, but died in a short time thereafter. The colonel of the regiment suspecting poison, desired the surgeon of the regiment to examine with great care the body of the deceased, which was accordingly done. The only morbid appearance discovered upon dissection, was a large bag of hydatids, which filled by far the greater part of the right lobe of the liver.

Of the Nerves of the Liver.

The liver is supplied with numerous nerves from the semilunar-solar ganglion, formed by the conjoined sympathetic and eighth pairs of nerves.

The nerves of the liver are small in proportion to the bulk of that gland. They pass along the coats of the vena portæ and hepatic artery, and may be traced, by a careful dissection, for a considerable way through the substance of the liver.

The liver, in its sound state, is not an organ of much sensibility. I have endeavoured to ascertain the degree of sensibility of this organ in a healthy living animal, by the application of stimuli to different parts of the convex surface; but the animal did not seem to suffer pain, even when one of the lobes was removed.

Of the Lymphatic vessels of the Liver.

The liver is very largely supplied with lymphatic vessels. There are two sets of these, a superficial, and deeper seated set, which freely communicate with each other. The superficial set is disposed somewhat like the branches of a tree; the larger branches are next to the diaphragm.

The superficial lymphatic vessels of the liver are more frequently seen than those of any other part of the human body, and they may be very readily filled with quicksilver, for their valves do not perform their office accurately. The mercury flows in a direction contrary to the valves, or from the larger into the smaller branches. There is a free communication between the superficial and deeper seated lymphatic vessels of the liver; so that, by injecting any large trunk, the greater number of the vessels may be filled.

The lymphatic vessels of the convex surface of the liver perforate the diaphragm, accompany the internal mammary artery, and pour their contents into the thoracic duct, near to its termination, at the junction of the internal jugular and subclavian veins.

I have frequently seen a number of lymphatic vessels of considerable size, arising from the concave surface of the right lobe of the liver, near to the fundus of the gall-bladder; these vessels passed along with the ductus communis choledochus, and entered the thoracic duct opposite to the origin of the cœliac artery.

There are some of the lymphatic vessels of the liver which pass backwards and upwards, and terminate on the right side in the large lymphatic trunk, which goes into the right subclavian vein, near to its junction with the internal jugular vein.

It may be further observed, that the neighbouring lymphatic vessels of the liver have their valves disposed in contrary directions; for in the concave part of the liver, there are many lymphatics which pass from the anterior edge of the liver backwards and downwards, along its concave surface to the thoracic duct, but in the convex surface the flow is upwards and backwards.

Of the Biliary Ducts.

The biliary ducts take their origin from the extremities of the vena portarum, in the substance of those small bodies called the Acini of the Liver. They join together, become gradually larger, accompany the branches of the hepatic artery and veins, so as at length to form two large trunks, which, by their union, form the trunk of the hepatic duct.

The hepatic duct, which is about the size of a common writing quill, and of a cylindrical form, passes downwards between the layers of the smaller omentum, enveloped in fat and cellular membrane, to the right of the vena portæ.

The trunk of the hepatic duct is rather larger than the duct from the gall-bladder, with which it unites at an acute angle, forming the ductus communis choledochus, which is larger than the hepatic or cystic ducts.

The cystic duct has a corrugated appearance. There are from fourteen to eighteen transverse folds within the cystic duct, which are somewhat different as to breadth, and are disposed in a spiral direction. The same kind of structure may be observed in the ductus communis choledochus. In a few cases, the pancreatic duct joins with the common duct.

The common duct descends at the posterior and left side of the first turn of the duodenum. As it approaches that intestine, covered by the head of the pancreas, it passes with a considerable degree of obliquity, for the space of about an inch,

along the posterior and inferior part of the second turn of the duodenum, and then perforates the muscular and villous coat of the duodenum, about four inches distant from the pylorus. At its termination, there is a distinct prominent orifice, which is somewhat rounded above, and is bounded on each side by a narrow descending portion, as has been very faithfully represented in SANTORINI's 12th Plate.

The ductus communis choledochus is not of an uniform diameter, but somewhat contracted, where it passes obliquely between the coats of the duodenum.

The oblique passage of the common duct through the coats of the duodenum, has the same effect as a valve, preventing the reflux of the bile, and even of air from the intestine; for the more the intestine is distended, the more the reflux of the bile is resisted.

Of the Coats of the Gall-Ducts.

The coats of the biliary ducts are thicker than those of the hepatic artery or vena portarum.

There are three coats proper to the gall-ducts:—an external fibrous coat; an internal mucous lining; and, between these, a few pale coloured and very thin fibres may be distinguished; but these have neither the most usual reddish colour, nor the regular fasciculated appearance of muscular fibres. Such muscular fibres are very conspicuous in the horse; and, in the dog, the muscular fibres of the gall-ducts are quite obvious. They pass in a longitudinal direction.

Some authors, who have entertained doubts as to the muscular structure of the gall-ducts, have affirmed that these ducts possess neither irritability nor contractility, because these are often much enlarged, in consequence of repeated fits of gall-stone jaundice. But the heart, bladder, intestines, ureters, and other canals, which have been universally admitted to have muscular coats, are also occasionally much enlarged when any impediment prevents free exit to their contents; and, besides, I have seen these ducts irregularly contracted upon the gall-stones, in two or three different places, in the same manner as the ureters are contracted upon

the urinary calculi contained within them. In the healthy body, the gall-ducts seem to possess but a small share of sensibility, and do not evidently contract when irritated; but, when irritated by the presence of gall-stones, they acquire a marked sensibility, which may probably afford an explanation of the cause of the acute pain which patients afflicted by gall-stone jaundice suffer.

It cannot be doubted, that the ducts of all the glands are more or less irritable, and are endowed with a muscular power; and it seems not improbable, that the smaller branches are even more so than the larger trunks. Besides, in the experiments above mentioned, in which one of the lobes of the liver had been cut out, if the biliary ducts had not possessed a contractile power, the bile would have been effused into the cavity of the abdomen, and must have proved fatal to the animal. Upon the mucous lining, there are a number of small orifices, through which a mucous fluid is discharged: these orifices are scarcely visible, but when the gall-ducts have been enlarged in cases of gall-stone jaundice.

That the coats of the gall-ducts often attain an unusual size, when the free flow of the bile into the duodenum has, from a mechanical cause, been interrupted, has been long known; but the degree to which these ducts may be expanded, and the short time in which that happens, was, I believe, first ascertained by the experiments of my father; and of which I possess a statement, bearing date 1773.

He threw a ligature around the ductus communis choledochus of several pigs. Soon after the experiment, an universal jaundice took place, and even the bones had assumed an orange colour. The words of the original manuscript are, "*The stoppage was such as to occasion vast dilatation* in the course of twenty hours."

"In one pig, the lymphatic vessels of the liver seemed to contain a yellower coloured liquor than elsewhere. In three others, I tied the ductus communis choledochus, and sewed up the wound in the abdomen. In one, I opened the wound next day. In a second, I opened it two days afterwards, and after I had tied the thoracic duct at its termination. In a

third, the abdomen was not opened till a month afterwards. All were opened alive. In all the three, the lymphatics were enlarged sensibly, and all contained a yellowish green and bitter tasted liquor, evidently bilious. In the second, the yellowish green colour and bitter taste could even be distinguished in the thoracic duct. In all, the biliary ducts were enormously enlarged."

Of the Gall-Bladder.

The gall-bladder is an organ which is not common to the whole animal creation. It is wanting in the elephant, horse, stag, camel, rhinoceros and goat; in some of the cetacea, and in some birds, as the ostrich, pigeon, and parrot: hence it may be considered rather as a convenient than an essential organ; and, in those animals in which the gall-bladder is awanting, the ductus communis choledochus is of unusual size, probably to make up for the want of the gall-bladder.

The human gall-bladder is sometimes deficient. Mr BRYCE told me he had met with such a malconformation in the person of a fat woman who died from jaundice.

It may be also said to be awanting, in some cases, in the human body. I have seen it completely filled by a gall-stone, around which it was so firmly contracted that no bile could enter it; or a stone in the cystic duct impedes the entrance of the bile; and, in some of the organic derangements of the liver, in which that organ had attained an unnatural bulk, combined with an enlargement and induration of the lymphatic glands of the capsule of GLISSON, such a degree of pressure was made on the gall-ducts as prevented the bile from getting into the gall-bladder, for the gall-bladder was found to contain only mucus.

In animals that have fasted for a long time, the gall-bladder and biliary ducts have been found very much distended with bile.

This is not to be imputed to the stomach being empty, as MORGAGNI supposed *, which, therefore, did not force the bile out of the stomach; for, according to HALLER, the sto-

* MORGAGNI, Epist. Anat. Med. 28. art. 6.

mach itself has been found full of bile, and when death has been occasioned by inanition, a vomiting of bile has preceded the death of the animal *.

Cuvier has remarked, that the presence of a gall-bladder is absolutely necessary to carnivorous animals, and is connected with their habit of long fasting; but there are some exceptions to this remark; for the porpoise, a truly carnivorous animal, has no gall-bladder.

The human gall-bladder is not uniform as to its form or size; it varies in individuals even of the same age, and still more at different periods of life, the gall-bladder of the fœtus being somewhat rounded, whereas that of the adult is oval, pyriform or oviform.

The gall-bladder, generally speaking, is capable of containing about an ounce of bile, and has usually been divided into three parts, a fundus, a body and neck.

The gall-bladder is imbedded within a fissure of the concave part of the right lobe of the liver, and retained in that situation by the peritonæum passing across it, and by short cellular substance, and also by a number of small bloodvessels and absorbents. The neck of the gall-bladder is placed in the sinus venæ portæ, and the broader end or fundus of that organ extends to the notch in the edge of the liver: it is rather lower in our erect posture than the neck; but in the horizontal posture the fundus becomes higher than the neck of the gall-bladder.

When the gall-bladder has been much distended with bile, the larger end forms a prominent tumour, which projects beyond the margin of the chest nearly opposite to the cartilage of the second false rib; and in a few cases, where a stone has been lodged in the neck of the gall-bladder, that organ has been so much distended as to form a very considerable tumour in the cavity of the abdomen.

The gall-bladder is in contact with the pylorus,—a circumstance which is obvious, from the yellow tinge given to it, by the bile exuding through its coats after death.

* Haller, Physiol. lib. xix. s. ii. 11.

Of the Coats of the Gall-Bladder.

Anatomists do not agree as to the number of coats proper to the gall-bladder. Some have described only two coats, the peritonæal and mucous coats. Others have added a third or cellular coat. In my opinion, there are four coats proper to the gall-bladder, viz. a peritonæal coat; a thin stratum of muscular fibres, passing in different directions, which are of a very pale colour; a cellular coat, in which a number of blood-vessels are situated; and an internal mucous coat, which is gathered into a number of folds, so as to form an appearance somewhat like the cells of a honeycomb, which are of various sizes, and are very small at the neck of the gall-bladder.

The muscular structure of the gall-bladder has been denied, because it is not obvious to our imperfect senses; but if the gall-bladder adapts itself, on all occasions, to its contents, and assists in expelling these, and also contracts, in a living animal, when mechanically irritated, which I have seen take place for the space of half an hour, by which it somewhat resembled an hour-glass; and if it contracts upon a small gall-stone, as firmly as the bladder of urine, we might, with as much truth, deny the existence of the muscular coat of the bladder of urine, as that of the gall-bladder.

In farther proof of the analogy between the structure of the gall-bladder and of the bladder of urine, it may be observed, that when gall-stones have been accumulated within the gall-bladder, the fibrous appearance is, as in a bladder of urine containing a urinary calculus, more apparent than in a state of health.

The mucous membrane of the gall-bladder is gathered up into a number of folds, which cross each other, so that there are upon the mucous lining of the gall-bladder, a number of ridges, and within these there are still smaller ridges; hence the inner membrane of the gall-bladder bears some resemblance to the inner membrane of the stomach, but on a smaller scale.

The inner membrane of the gall-bladder is largely supplied with bloodvessels, and assumes, in consequence of inflamma-

tion, or when its vessels have been filled by a fine injection tinged with vermilion, a deep red colour.

There are on the internal surface of the gall-bladder a number of follicles, especially near to its neck; these secrete a mucous fluid, to defend the inner membrane from the acrimony of the bile.

The neck of the gall-bladder, as also the duct connected with it, called cystic, describes a tortuous course; and, upon opening the latter, there are 16 or 18 transverse folds of a semilunar shape, which probably act like valves, and retain the bile for a longer time within the organ, and also a few smaller folds in the common duct.

Sir E. Home, in support of his opinion, that the contents of the lower intestines are converted into fat, by means of bile, has observed:—"A child was born at the full time, and lived for several months, but never appeared to increase in size; although it fed heartily, and had regular stools. The food appeared perfectly digested. There was no bile in the stools, and the skin was of a dark yellowish brown colour. I saw the child while alive, and was struck with its want of growth, and its having no fat under the skin, which made it appear larger than new-born children generally are. Upon examining the body after death, the only malformation met with was, that there was no gall-bladder, and no duct leading from the liver into the duodenum.

"From what happened in this case, a supply of fat seems necessary for growth; for the child was by no means wasted in its muscles, which it must have been, had the constitution not been supplied with nourishment *."

SECTION II.

OF THE LIVER OF THE FŒTUS.

The liver of the fœtus is proportionally much larger than that of the adult, and it is proportionally larger in the very young embryo, than in the fœtus of nine months, so that it occupies not only the hypochondriac, but also a part of the

* Sir E. Home's Comp. Anat. vol. i. p. 482.

umbilical region, and in a very young fœtus occupies a still greater share of the abdomen. As the diaphragm of the fœtus is flatter than that of the adult, the liver of the fœtus does not hold the same relation to the neighbouring parts as that of the adult it is not placed in an oblique direction as in more advanced life, but in a perpendicular direction: the anterior surface is in contact with the parietes of the abdomen, and the posterior with the stomach and spleen, so that these organs are covered and concealed by the liver.

The shape of the liver of the fœtus is not exactly the same as that of the adult; it is flatter, and not so sharp towards its lower part.

There is another remarkable difference between the liver of the adult and fœtus;—the right and left lobes are nearly equal as to size.

The umbilical vein passes from the navel in a duplicature of peritonæum, to the left branch of the vena portæ; and a considerable quantity of blood flows from the left branch of the vena cava by the medium of the canal called Canalis venosus.

The liver of the fœtus is softer than that of the adult: it is even more vascular, and rather of a deeper colour, than that of the adult.

Different opinions have been entertained as to the use of the great size of the liver of the fœtus.

The liver of the fœtus has been stated to perform the functions of the lungs of the adult; hence, it is voluminous in the fœtus; also in reptiles that breathe slowly; and, on the other hand, the liver of birds is very small, because the lungs are very capacious.

Mr Bryce is of opinion that the liver of the fœtus in utero is of large size, in order that, by its shrinking, when the child is born, there may be sufficient room for the free expansion of the lungs, and the free circulation of the blood through that organ.

The contents of the gall-bladder of the fœtus of four months, are very different from those of the gall-bladder of the adult; that organ being filled by a reddish mucus; and

even at the ninth month, the bile is by no means so acrid and bitter as that of the adult.

Of the Bile.

The bile which is contained within the gall-bladder is more viscid, ropy, and more bitter than that within the hepatic duct: which circumstance has given rise to the opinion, that there are two very different kinds of bile, one kind secreted by the liver, the other by the bloodvessels in the villous coat of the gall-bladder, a fact which was supposed to be confirmed by analogy. ALBINUS remarked, that the cystic and hepatic ducts of the domestic fowl do not form a common trunk, but run in a direction parallel to each other, and open separately into the duodenum.

My Father examined this matter many years ago with attention, and found that the gall-bladder of the domestic fowl received its bile, by hepato-cystic ducts, and that such were always to be found when the hepatic duct was not evidently connected with the cystic duct between the liver and duodenum, but were wanting in those instances in which the trunk of the hepatic duct was connected with the cystic duct: hence the cystic bile of all animals is derived from the liver.

As the cystic bile is derived from the liver, and as in man there are no hepato-cystic ducts, the bile must pass to and fro in the cystic duct, and probably by means of a peristaltic and antiperistaltic power: from this cause chiefly the bile is pushed upwards into the gall-bladder and returns again, just as the alimentary matter is moved to and fro in the intestina cæca of a fowl.

Of the Chemical Analysis of the Bile.

Bile is an animal soap.

Bile contains, according to Mr THENARD, some yellow matter suspended in it: and when evaporated to dryness, it leaves a brown matter, amounting to about $\frac{1}{11}$th of its original weight. The following substances, and the following proportions of these, were obtained by THENARD * from 1100 parts of human bile.

* Vide Mem. d'Arcueil, tom. i. p. 58.

1000.0 Water.

from 2 to 10 yellow insoluble matter, yellow matterr in solution, a trace.

41.0 Resin.

42.0 Albumen.

5.6 Soda.

4.5 Phosphate of Soda, Sulphate of Soda, Muriate of Soda, Phosphate of Lime, Oxide of Iron; but no Picromel, like ox-bile.

A favourable opportunity occurred for examining bile, which Dr JOHN DAVY examined at my request.

I have subjoined his account of it in his own words.

"*Healthy Bile obtained from a person executed.*

"This bile appeared, by transmitted light, of a fine golden yellow colour, darker and richer than the healthy bile of the ox; and by reflected light it assumed the hue of burnt timber. It was rather more viscid, and also of greater specific gravity, than the ox-bile. The former, water being as 100, was found to be as 104.25, and the latter 102.75.

"It had nothing peculiar in its general properties, or different from those commonly observed.

"One hundred grains of it, slowly evaporated to dryness, afforded fifteen grains of solid residue, of a resinous appearance, and of a dark brown colour.

"This residuum, treated with alcohol, was completely dissolved, with the exception of 1.5 grain, which had the properties of albumen.

"The quantity examined was not sufficient for minuter analysis."

From the preceding results it may be concluded, that 100 parts of this human bile contain about

86.0 Water.

12.5 Resin of Bile.

1.5 Albumen.

100.0

Of the Uses of the Bile.

Having considered the source from which the bile is derived, and the course which it follows after having been secreted, it is necessary in the next place to turn our attention to its various uses.

1. It stimulates the alimentary canal; for when it is secreted in too small quantity, or if it does not find its way into the duodenum, costiveness follows; and on the other hand when secreted in too large quantitity, vomiting and purging take place.

It may perhaps be a question, whether the languor which commonly attends jaundice, be owing to the want of the stimulus of the bile upon the alimentary canal, or to its sedative effect upon the whole system, after it is absorbed in greater than common quantity.

2. The bile, in common perhaps with other bitters, blunts acidity. Whether it dissolves in the duodenum, coagula such as that of milk formed by the gastric liquor and acids in the stomach, has not been proved by experiment; but it seems probable, that, in consequence of its blunting acids, and at the same time stimulating and exciting the action of the intestines, clotted milk is not so often observed in the small intestines or stools of children, as might have been expected. Many circumstances concur in proving the very stimulant properties of the bile, when it is effused into the stomach.

3. It appears to me highly probable, especially when we attend to the joining of the pancreatic duct with the biliary, and consequent intimate mixture of these liquors, that the bile contributes to mix the watery and oily parts of our food; it also probably assists in forming the chyle, in a manner which want of experiment prevents us from being able to specify.

4. As the bile is secreted chiefly by a vessel formed by the union of veins, and in which, therefore, the blood is flowing in a second circle, and remarkably dark in its colour, there is room for suspecting that the system may thus relieve itself, by discharging what is hurtful to it, by the medium of the bile, or that some part of the bile is excrementitious. There is rea-

son for believing, that the effusion of bile into the cavity of the abdomen is attended with great immediate danger. Although, in jaundice, the serum is deeply charged with bile, without creating any immediately dangerous symptoms, yet even a small quantity of healthy bile getting into the stomach, produces severe nausea and vomiting. It may be farther remarked, that Cholera Morbus is a dangerous disease, although it be occasioned by eating acid fruits, and unconnected with any previous disease of the liver.

My Father, in order to learn the effect of bile, by means of a trocar, injected bile, taken from the gall-bladder of an ox, into the cavity of the abdomen, and found that it proved fatal in a short time.

Experiment 1.—1773, *July* 3. He injected half of the bile in an ox's gall-bladder into the cavity of the abdomen of a brown rabbit. It screamed immediately thereafter, as if much pained; soon grew languid, so as scarcely to be able to walk; and died about two hours thereafter. On opening its body next day, all the bowels were wet with bile, but not above a quarter of an ounce of it could be collected. A good deal of it was effused between the skin and muscles of the abdomen. There was no appearance of inflammation in the bowels; and I need scarcely add, that the white of the eye was not discoloured in so short a time.

Experiment 2.—1773, *July* 3. He squirted the other half of the bile in the ox's gall-bladder, under the skin, on one side of a white rabbit. It seemed a good deal hurt, and screamed aloud. After an hour it ran about the room with great agility. Next morning it was found dead. There was no yellow colour certainly distinguishable in the eyes, the fat, or bones. The skin and muscles, where the bile was lodged in the cellular membranes, did not appear to be inflamed.

Experiment 3.—1773, *July* 13. He made two small holes in the skin, on each side of the spine of a pig, through which he injected into the cellular membranes 10 or 12 ounces of ox-gall. The animal was, in a few minutes, affected by this to such a degree as not to be able to walk, and scarcely to crawl out of the place in which it was laid. Soon after, it began to

breathe very laboriously; and the weakness increasing, it died after four hours.

Founding on what has been above stated, my Father proposed, in the case of wounded gall-bladder, that, instead of endeavouring to sew up the wound in the gall-bladder, the wound of the abdomen should be dilated, and a ligature should be thrown around the top of the cystic duct, or neck of the gall-bladder, which he practised, without much difficulty, several times on dogs and pigs, and without killing the animals. At the same period, my Father also made a number of experiments upon animals, with the view of determining whether jaundice proceeded from an absorption of bile. These experiments led him to conclude, that the valvular lymphatic vessels convey the bile to the blood.

He has stated in one of his manuscripts, "I opened the cavity of the abdomen of a number of living animals, and threw a ligature around the ductus communis choledochus, and then sewed up and healed the wound. Jaundice was in consequence produced. I kept these animals alive for a few hours only, or for a number of days, and several of them for some weeks, the depth of the yellow colour daily increasing. I opened their abdomen a second time at different intervals, after having tied up the biliary ducts, and found in all of them, *that the lymphatic vessels contained a yellow fluid different from that which was conveyed by the lymphatic vessels from other organs, or from the liver in the usual state*; *and, on cutting transversely the lymphatic vessels of the liver, and receiving their contents into a spoon, the lymph had not only a yellow colour, but a bitter taste, resembling that of bile.*

"I particularly attended to the colour and taste of the lymph in those animals in which the ligature had been around the gall ducts for a few hours only, lest it should have been supposed that the blood had been tinged by the bile, by the medium of the venæ cavæ hepaticæ, and that this tinge had been communicated to the lymph of the body in general, and afterwards secreted into the cellular membrane universally, and of course into that of the liver, and then only taken up by the lymphatic vessels."

SECTION III.

OF BILIARY CALCULI.

Through the kind offices of Dr John Davy, I have been enabled to present to my readers the subjoined very valuable account of Biliary Calculi, which he was so polite as to draw up at my particular request.

From the considerable attention paid, of late years, to animal morbid concretions, several interesting facts have been discovered; and I may remark, that the knowledge which has been acquired, though indeed purely chemical, and confined to the compositions of these substances, without throwing light on the mode of their generation, has not been destitute of use; as it has at least shewn what is to be avoided as inert or injurious in practice; and as it has at least dispelled many delusions, that ignorance previously led to, and thus certainly has been of no little advantage in medicine. As is always the case, those concretions have been most examined which have excited the liveliest interest. Urinary calculi are of this description; and their chemical and natural history is now pretty perfect. Other concretions, at the same time, of less consequence in relation to disease, have been much neglected; and their history remains very imperfect, or far from complete. Of this latter description I need not say are biliary calculi. Several circumstances have impeded our acquaintance with these bodies; their comparatively rare occurrence; their being seldom the cause of death; the spontaneous cures that nature often produces; their not admitting of extraction by surgical means; and, lastly, no controversy of any general interest having yet arisen respecting either their formation, nature, or cure. The imperfect knowledge I allude to, is evident, on consulting the most recent systematic works; from which it appears that few species have yet been established, and some of these very imperfectly; that human biliary concretions have almost alone been examined; and, in fact, that much yet remains to be accomplished. Before proceeding to the descriptions of

the experiments I have made, I have only to add, that these prefatory remarks are introduced not only as an apology, in some measure, for the imperfection of the following pages, but also on another account, to draw attention to a subject interesting in itself, and highly worthy of inquiry.

The concretions which form the subject of this paper belonged to Dr Monro, and it was at his request that I examined them: with the exception of two, they all belonged to the human subject.

As many of this number were similar in chemical properties and composition, it would be useless, therefore, to give an account of the experiments that were made on each individual; and it will be quite sufficient to describe the mode of analysis followed in one instance of each kind. But, on the contrary, as the different specimens individually varied from each other more or less in their appearance, and the proportion of their constituent parts, general description will not be sufficient; it will be necessary to describe particularly the varieties of colour, figure, &c. and to notice the proportions of the different ingredients, when these are ascertained.

I shall commence with the analysis of a single specimen of each kind, and shall select the purest, as best adapted to the object in view.

No. 1.—This concretion, of an irregular oval figure, was nearly the size of a pigeon's egg. Externally, its colour was an impure white, and internally, a perfect white; it was soft, and of glittering foliated texture, very like spermaceti. It sunk in water, and it was found to be of specific gravity 1054. Gently heated in a platinum spoon, it melted, and, on cooling, crystallized unaltered. When rapidly and pretty strongly heated, it rose in dense fumes, having an odour somewhat resembling melted wax, took fire, burnt with a strong bright flame, and consumed without affording any sensible residue. When heated in a close vessel, it appeared much more fixed, and could scarcely be said to volatilize or sublime, for it seemed rather to flow from the part most strongly heated, as if driven by repulsion, than in consequence of assuming the gaseous

state. It did not melt in boiling water, nor did it ever appear to be softened. Cold alcohol had little effect on it, but hot alcohol rapidly dissolved it; and, on cooling, a copious deposition took place, in the form of minute white crystalline plates. I found, that 640 grains of alcohol, of the specific gravity 0.856, were required to keep a single grain of the calculus in solution on cooling; yet, even in this instance, after two or three hours, part of the grain was deposited. Nitric acid, whilst cold, appeared to produce no change; yet, when heat was applied, a strong effervescence instantly took place, copious dense red fumes of nitrous gas were evolved, and the calculus melted, or acquired the appearance of a yellowish oil, and swam on the surface. When cooled and thrown into water, the acid became slightly turbid, and, the fused matter became a soft viscid solid, of a light greenish colour, and appeared to differ from its original. It melted in hot water, before the water had acquired the boiling temperature, and even in alcohol before ebullition; and, it seemed very slightly affected by the latter, for, after being boiled in much more than was sufficient for the solution of double the quantity of the calculus, its bulk seemed undiminished; on cooling, there was no immediate deposition; and on the addition of water, only a slight cloudiness was produced. Thus it appears, that, by the action of nitric acid, the peculiar substance of this concretion is converted into a matter somewhat resembling a fixed oil, and most likely by the addition of oxygen. Sulphuric acid immediately rendered the calculus of a dark cochineal red colour, and the acid itself acquired a slight reddish hue: when heated, it suddenly became very darkly coloured, and emitted sulphurous acid gas. This solution was transparent: held between the light and the eye, its colour seemed dark reddish-brown; and, in the contrary position, dark olive-green. Acetic acid had little, if any effect, on the calculus when cold; but heated, it produced a speedy solution, and, on cooling, the greatest part was again deposited, though less apparently than from alcohol. Lastly, were tried on the calculus the oxalic and tartaric acid, ammonia, and potash; but no effect was perceived to be produced. From

these experiments, it is evident, that the matter of this calculus is of a peculiar nature: in some respects, it is similar to spermaceti, and in some to the saponaceous matter formed from muscular flesh; but it is not perfectly identical with either of these. It differs from spermaceti in being less fusible, for spermaceti melts in boiling water in being more soluble in alcohol, and by the change which it undergoes with nitric acid, and which spermaceti is exempted from. It differs from the saponaceous matter in being less fusible, and less soluble in alcohol, and in the peculiar change that nitric acid effects, and which the saponaceous matter does not suffer, as I was well able to ascertain, on a specimen which I was furnished with through the kindness of Dr Hope, and who informed me that he received it immediately from Dr Gibbs. The calculus is much more like adipocire; that substance first found by Fourcroy in biliary calculi, and described by him; and the present, indeed, may be considered a perfectly pure example of this species.

No. 2.—This concretion was found in the gall-bladder of an ox. It appeared of a circular form, and composed of concentric layers, that readily separated from each other. Externally, it was smooth, slightly shining, of a dark chocolate colour; its fracture was slightly conchoidal, and it was very brittle and friable: internally, the layers were of different shades of colour, and all lighter than the external. It excited, in a slight degree, the peculiar sweetish bitter taste of bile; and after it had been digested in water, in the state of powder, it emitted a slight odour of musk. Its specific gravity was found to be 1170. When heated in a platinum spoon before the blowpipe, its volume increased, it burned with a slight flame, and had the smell peculiar to vegetable matter in combustion; the fixed residue, of a reddish-white colour, retained the form of the swollen mass, but, by a strong heat, its bulk was reduced; and when thus heated, it phosphoresced with a brilliant white light, like that produced by phosphate of lime, that has been combined with animal matter when similarly treated; 1 grain of the calculus afforded $\frac{1}{10}$th grain

of ash. I may here mention the experiments that were made, to ascertain the composition of this ash. It was first digested in water; the water immediately reddened turmeric paper, but after a few hours it lost this property, and was covered with a slight white crust; and hence we may infer the presence of lime. On the addition of a drop of nitric acid, numerous small air-bubbles were disengaged; and, with the exception of a few reddish particles, a speedy solution took place. This solution was tried by different tests; by nitrate of silver it was rendered slightly cloudy; and by ammonia in excess, a pretty copious precipitate was produced, which appeared to be increased rather than diminished, by oxalic acid; and the filtered solution, after the addition of the oxalic-acid, was not affected by the volatile alkali. Muriatic-acid partially dissolved the reddish particles, and prussiate of potash rendered this solution of a light-green colour. From these results, it appears, that the ash consists chiefly of phosphate and carbonate of lime, and of a little iron.

6 grains of the concretion in the state of powder, were exposed for three hours on a steam-bath, to a temperature of about 120° Fahrenheit, and the loss thus sustained, amounting to $\frac{1}{2}$ grain, was probably nearly water.

Two grains of the powder were digested in four ounces of water on the sand-bath. The solution formed, after two or three hours, had the peculiar taste of bile, and the musk-like odour in a slight degree; and it was of a light-yellow colour. The digestion was repeated with an additional quantity of water for many hours, but nothing more was abstracted. The undissolved matter, dried on the steam-bath, weighed 1.3 grains, and it was now much darker than originally.

The same residual matter was next digested in half an ounce of alcohol, to which it soon imparted a yellow colour; but after a second digestion with an equal quantity, very little was found dissolved, scarcely the one-tenth of a grain.

From the preceding experiments, it appears, that the calculus is chiefly composed of inspissated bile, of a brown matter,

and of water; and of each of these, nearly in the following proportions:

65.0	brown matter.
36.7	bile.
8.3	water.
100.0	

As the brown matter seemed to be of a peculiar kind, it may not be improper to mention its chief properties, and the experiments that were made, to become better acquainted with its nature. It was destitute of taste or smell, and was perfectly opaque. It burnt with a bright flame, and emitted an odour similar to that afforded by vegetable matter in combustion. It increased very little in volume; was quickly calcined, and left much ash; much more in proportion than the original concretion; so that the earth present, may chiefly, with propriety, be attributed to it. A strong solution of potash entirely dissolved it: the solution was transparent, and of a dark greenish-yellow colour. Cold muriatic acid had apparently no effect on it; but when heat was applied, a complete solution of a fine greenish-blue colour was produced, which was not rendered turbid by water; the only change produced was in respect to colour, which, from green, had become perfectly blue. Nitric acid immediately acted on it; red nitrous fumes were disengaged; and, in a short time, a dark-red transparent solution was formed, which was rendered slightly turbid by water. Sulphuric acid immediately darkened the powder, and itself acquired a fine emerald green colour, which it imparted to water; when heated, sulphurous acid gas was disengaged, and carbon precipitated. From these experiments, and others which I might mention of a negative nature, it is evident, that this brown matter is very different from inspissated bile. In many of its properties, it approaches fibre; and, on the whole, more resembles it, than it does any other substance I am acquainted with.

No. 3.—This concretion, in size nearly equal to a common nutmeg, and of an oval form, was also found in the gall-bladder of an ox, and its appearance was very similar to the last de-

scribed. It chiefly differed in the following trifling circumstances. It was of a lighter and more uniform colour; its external surface was scarcely darker than the external layers, and both were similar as to roughness and want of lustre; it also had a stronger taste of bile. Like the preceding, it contained no adipocire, at least no notable quantity; for a little alcohol, digested with a large portion of the concretion, and filtered whilst hot, remained perfectly transparent on cooling. From experiments similar to the last, this concretion appeared to consist principally of brown matter and bile.

No. 4.—The appearance of these calculi, which were four or five in number, was peculiar; they were of different sizes, all small, excepting one about the size of a filbert, but all were similar in form, which approached nearer to the cube than any other figure; their external surface was of a dark shining black, rough, and unequal; in each a nucleus was found, consisting of a light yellowish substance, of a lamellar texture, and similar, in appearance, to adipocire. The black matter (of which the calculi were chiefly composed, at least the small ones I examined) was brittle, and had a brilliant conchoidal fracture, not unlike jet; its taste was peculiar and resinous, something like that imparted by oil of turpentine, very diluted; and it had a corresponding resinous smell. Heated before the blowpipe, without any of the nucleus apparently present, it entered into a state of semifusion, swelled in bulk extremely, burnt with a brilliant flame, and left a black empty vesicle, more than ten times the original bulk, which, when strongly heated, was reduced to a most delicate film of white earthy matter, in appearance like net-work. I regret that I could not ascertain the nature of this earthy residue: the smallness of the quantity operated on, prevented it; and from the same cause, I was only able to learn the effects of a few re-agents, on the concretions themselves. Reduced to powder, with the nucleus present, and heated in a small quantity of alcohol, a very partial solution took place, which, filtered whilst hot, deposited on cooling a crystalline film, like adipocire. The black residue was boiled in several portions of alcohol successively:

to each it imparted a fine green colour, but appeared very little, if at all, diminished in bulk. It was next boiled in water; the water acquired neither colour nor taste; and no solution was effected. Heated in muriatic acid, no apparent change was produced; and the acid was rendered only a little browner in colour. Sulphuric acid, poured on it, after the preceding had been removed, and the substance washed with water, had no immediate effect, but when heat was applied, the acid became of a dark colour, and thick consistence, and sulphureous acid gas was evolved. Some of the powder, digested in a hot solution of potash, was only partially dissolved, the black matter seemingly remaining unaffected. Thus, in a few particulars, this substance differs from the matter contained in the biliary calculi of the ox just described:—besides the difference of colour, the black matter swells more when heated, and leaves less earthy matter; has a different taste and smell, and is very slightly acted on by concentrated sulphuric acid without the assistance of heat, or by muriatic acid even boiling, or by a strong solution of potash. As to the composition of these calculi, they may be said to consist of a little adipocire, chiefly existing in the central part; and of this black matter, the exact nature of which, farther experiments are required to determine.

I shall now proceed to the calculi, into the composition of which a greater number of ingredients is concerned; and I shall arrange them in the order in which they were examined.

No. 5.—These calculi were very numerous, no less, I was informed by Dr Monro, than 1500; and they were all found in the same gall-bladder. The appearance of all was similar, but they varied much in size; most of them were very small, and none so large as a hazle-nut; all of them were polygonal, and several had six or eight sides, and approached, in form, to the regular trihedral or tetrahedral pyramid: externally, the colour of some was white, or greyish white; their lustre was pearly, and their appearance and texture micaceous; they had a greasy feel, and in this respect, and in others, resembled the pure adipocire, already described; and they were

equally destitute of taste, excepting the central part, which differed from the rest, and had the peculiar taste and smell of inspissated bile; it was found in every concretion, and, on account of the slight transparency of the adipocire, this black nucleus was seen in many, through the external coat. The greater number of these sank in water, a few did not; and these, when broken, were found to contain small cavities. Their specific gravity was ascertained to be 1050. But, according to GREN, the specific gravity, of this species, is less than that of water, no more than 0.803. Without doubting the correctness of his experiments, I cannot help suspecting that they were made on entire calculi, or on fragments containing air, as, in every instance, I have found this species to sink in water, when proper care was taken to break down the cavities, and separate the adhering air-bubbles.

After what has been already said, of the general mode of analysis, I need not give an account of the experiments that were made, to ascertain the proportions of the constituent parts; it will be sufficient to mention the latter, which, in 100 parts, appear as follows:

80	Adipocire.
13	Bile.
2	Brown Matter.
5	Water.
100	

I should have stated, that the bile and brown matter were confined to the centre, and that the envelope, in general, was pure adipocire. It is obvious, that the proportions stated above, are only approximations to the proportions of the whole, and not of individuals, which, in this respect, must greatly vary, as, in some small calculi, large nuclei were found, and *vice versa.*

No. 6.—This calculus was of a polygonal form, and of a yellowish white colour, and very similar to the last; only differing in being less micaceous, and more compact. Its specific gravity was 1060. 100 parts were found to consist of

83	Adipocire.
12	Bile.
1	Brown matter.
4	Water.
100	

No. 7.—The form of this concretion was an irregular polygon; and it was about the size of a filbert. Its external surface had a marbled appearance, from zones and spots of black, on a white ground, but, in other respects, it was similar to the preceding; internally it was composed of black and white layers, or of an admixture of black and white coloured matter; the former were very thin, not above a line thick; and the latter, which greatly predominated, was slightly radiated. Its specific gravity was found to be 1133; and 100 parts appeared to consist of

75	Adipocire.
15	Bile.
4	Brown matter.
6	Water.
100	

No. 8.—These small calculi approached in form to the cube. Their colour was of a dull brown; they were of a greasy feel, and waxy lustre; were compact and brittle, and not at all of a laminated structure. All that were divided exhibited small black nuclei. They were of specific gravity 1050. 100 parts consisted of

70	Adipocire.
3	Brown matter.
27	Bile and Water.
100	

No. 9.—This was the fragment of a calculus. Its external surface was rough, and of a dark brown colour: internally it was of a white pearly appearance, and foliated texture. It readily sunk in water. The quantity was too small

to ascertain either its exact specific gravity, or the proportion of its constituent parts. From the experiments that were made the external part was found to consist of brown matter of bile, and the white internal of adipocire.

No. 10.—The form of this calculus was globular, and its surface rough and tubercular, and of a grey colour; in appearance very similar to the mulberry urinary calculus. Internally its colour was yellowish, with the exception of a dark brown zone. It was of specific gravity 1050, and consisted of

60.	Adipocire.
10.	Brown matter.
20.	Bile and water.
100.	

No. 11.—This concretion was of an irregular globular form. Its colour externally was dull brown, with some admixture of green. Internally it was soft, radiated, and of a brown colour. It sunk in water. It chiefly consisted of adipocire, with a little brown matter and bile.

No. 12.—The form of this calculus was irregular. Its colour externally was of a light green hue, and internally of a bright brown; and it possessed a large dark brown nucleus. It was soft, and heavier than water. It consisted of adipocire, and of a very small quantity of bile, and brown matter.

No. 13.—This concretion, of a globular form, and nearly the size of a nutmeg, was spontaneously discharged near the umbilicus of a female. It was composed of concentric layers of radiated fibres. Its specific gravity was 1070. It consisted of about

85.	Adipocire
1.	Brown matter.
14.	Bile and water.
100.	

No. 14.—This concretion was of an irregular polygonal form, and both externally and internally of a yellowish white colour. Its texture was uniform, with the exception of two

or three concentric layers of a light brown hue. Its specific gravity was greater than that of water; and it was found to consist chiefly of adipocire, with a very small portion of bile, and a still smaller proportion of brown matter.

No. 15.—The form of this concretion was an irregular four sided pyramid. Its colour was a very dark chocolate hue, and in some parts almost black. The surface was partly smooth and shining, as if it had received a polish, and partly rough and vesicular, not unlike cinder. It was brittle, its fracture was slightly conchoidal and shining, and nearly black; it was heavier than water. The quantity was not sufficient to admit of minute analysis. It was found to consist of brown matter, with a very small proportion of bile: the brown matter, from a few experiments that were made on it, appeared perfectly similar to that of the ox.

No. 16.—This concretion was externally dark brown, and internally, in some parts, greenish, and in others, light reddish brown. It was brittle, of a slight laminated structure, and conchoidal fracture. It seemed chiefly composed of brown matter, a little bile, and still less adipocire.

No. 17.—This concretion, which was passed per anum, was about the size of a pigeon's egg. It was externally covered with a whitish mould, too delicate to be examined, and it was composed of concentric layers, readily admitting of separation; they were brittle, of a slightly conchoidal fracture, and of a shining chocolate colour. It was of specific gravity 1180. It consisted of about

85. Brown matter.
15. Bile and water.

100.

No. 18.—These concretions, three in number, were examined immediately after they were taken from the gall-bladder of a recent subject. They were small, and of an irregular oval form; their colour was impure yellow externally, and internally dark brown; they had little lustre, a greasy feel, and both the surface and the brown nucleus had a strong taste of bile. They appeared to consist of a large portion of

adipocire, blended with a little bile, and very slight traces of brown matter, and albumen. The presence of albumen was inferred from the appearance of white flakes mixed with the minute quantity of brown matter that remained after digestion in hot alcohol.

No. 19.—This concretion was small, and of an irregular oval figure. Externally it was black and shining, and internally of a chocolate colour. It possessed a small yellowish white nucleus, of a soft consistence and greasy feel. The nucleus was found to consist chiefly of adipocire, with a very little bile; and the remainder of the concretion was composed of brown matter, with a slight admixture also of bile.

The nineteen preceding are certainly biliary calculi, the next two are of a doubtful nature.

No. 20.—This concretion was of an oval figure, and of a light brown colour. Its texture was fibrous and porous. It was tough, hard, and rough to the feel, and had no smell or taste. It sunk in water. Heated before the blowpipe it inflamed, and did not swell; emitted an odour similar to that of vegetable matter in combustion, and afforded much white ash. The ash was found chiefly to consist of phosphate and carbonate of lime; four grains were obtained from seven of the concretion, so that it contains 56 per cent. of earth. This combustible matter appeared most analogous to woody fibre; it was partially soluble in a strong solution of potash, and perfectly in nitric acid.

No. 21.—This concretion was of an oval form. Externally it was hard, and of a light brown colour; internally the colour was similar, but the substance different, as it was soft, compressible, and fibrous. The external layer, which was very thin, when calcined, left much ash, as much as 80 per cent., which consisted chiefly of phosphate of lime; the internal part, which burnt like vegetable matter, afforded much less.

This, as well as the last, very much resembled alvine concretions; and, as the history of them is unknown, as it is neither ascertained whether they were discharged per anum, or found in the gall-bladders, it appears much more natural to

refer them to the former than to the latter, viz biliary calculi, which they so little resemble.

The nineteen concretions described in the preceding pages, may be referred to three or four genera, or species, agreeably to the substances which enter into their composition, viz. adipocire, bile, the peculiar brown substance, and the black substance, should it be proved to be peculiar also.

It may not be improper to describe in this place the characteristic marks of each kind. Biliary calculi, consisting of pure adipocire, or much abounding in this substance, may be distinguished by their greasy feel, soft consistence, fusibility, and much greater solubility in hot than cold alcohol. Those calculi containing bile are characterized by the very peculiar taste of this substance, and its ready solubility both in alcohol and water, either hot or cold. Biliary calculi, consisting entirely or chiefly of brown matter, may be known by their colour, brittleness, slight conchoidal fracture, and the little effects of alcohol, or water on them. And, lastly, those concretions formed of black matter, may be distinguished (if farther experiments confirm the preceding results), by a peculiar smell and taste, intense black colours, and the slight action of either the muriatic or sulphuric acid, or a solution of potash. Respecting the admixture of the species, it is unnecessary to make any remark *.

PLATE I.

This Engraving represents two different organic derangements of the liver.

In Fig. 1., the acini of the liver, which had attained an unnatural size and form, were of a yellowish-red colour; and, in Fig. 2. the liver had attained a very uncommon degree of firmness. The cellular substance between the different acini of the liver was very much thickened, and the acini were much enlarged. The liver, when the drawing was made from it, was of a yellowish-green hue. The patient died from obstinate jaundice.

* The above observations of Dr JOHN DAVY on Biliary Calculi, were written during the year 1814.

PLATE I.

Fig. 1.

Fig. 2.

F. Sowe. all nat: del.t

F. Woolnoth. sculp.t

SECTION IV.

OF THE SPLEEN.

The Spleen is an organ which varies much in size and form in different animals. In quadrupeds, it is larger than in man, and not so much rounded in its shape; and, in all animals, is of a soft texture, somewhat spongy to the touch, very easily torn, and, when torn, is generally found to contain a good deal of blood, and to consist chiefly of blood-vessels, the smaller branches of which form an intimate network; and hence it has, by some authors, been said to be made up, in part, of a number of cells.

The human spleen, in a very recent subject, is of a greyish-blue colour, which, in a few hours, changes into a purple, so that it resembles a mass of clotted blood; it is somewhat variable as to shape and length, averaging between 4 and 6 inches.

The spleen has nearly a vertical position, and occupies a share of the left hypochondriac region, between the left extremity of the stomach and the corresponding false ribs, but changes its place a little, along with the stomach, with which it is connected by bloodvessels, peritonæum, cellular substance, and the greater omentum; or when compressed by that organ, and also during inspiration and expiration. The spleen may be divided into a convex and concave surface, and into two extremities.

The upper convex surface is received into a corresponding concavity of the diaphragm, and retained in that situation by the reflected peritonæum, and the concave surface is directed towards the spine. There is a distinct longitudinal fissure, which divides it into an anterior and posterior plane, at which the bloodvessels and nerves enter the liver, and the absorbent vessels pass out from that organ, in their progress to the thoracic duct. The under extremity of the spleen lies over the upper part of the left kidney, to which it is fixed by the peritonæum.

There are often deep fissures on the edges of the spleen.

We sometimes meet with one, two, or three smaller spleens appended to the larger one. The spleen has two distinct coats, one of which is derived from the peritonæum, the other is proper to this organ; it is of considerable thickness, is elastic, and is continued into the substance of the spleen, and envelopes the splenic artery and vein. In the adult, these coats are so closely connected with each other, that it is very difficult to separate them. The spleen is by far the softest of the abdominal bowels; and I have known it torn, during life, in consequence of leaping; and, when pressed upon, loses considerably of its bulk. It very rapidly passes on to a state of putrefaction. When a section is made of the spleen, it seems to be composed of a number of white partitions, and of a congeries of arteries, veins, nerves, and lymphatic vessels, which are united to each other by cellular substance; and the smaller branches of the arteries form an intimate net-work with each other, which has led to the idea of the existence of cells in the spleen.

The splenic artery takes its rise from the cæliac; it follows a serpentine course; and, after having reached the substance of the spleen, is subdivided into a number of very small branches, which cross each other, and form an intricate net-work of vessels. The accompanying vein is larger than the artery; and, after receiving the small veins which correspond with the vasa brevia of the stomach, forms one of the three great veins which, by their union, form the vena portarum.

The spleen varies much in bulk in proportion to the quantity of blood it contains, for if a ligature be thrown around the splenic vein, it swells out considerably; and, in the same manner, the stomach, when distended, forces out the blood the spleen contains.

Malpighi has described follicles as being interposed between the extremities of the splenic artery and the splenic vein; but I have never seen these.

The nerves of the spleen are small, and are derived from the semilunar-solar ganglion; and they creep along the coats of the splenic artery, upon which they form an intricate plexus into the substance of the spleen.

The absorbing vessels of the spleen are large and numerous. There is no excretory duct proper to the spleen; and hence we are much in the dark as to the use of this organ *.

SECTION V.

OF THE PANCREAS.

THE Pancreas resembles the salivary glands in its colour, consistence, structure, functions, and in the organic derangements to which it is liable. This conglomerate gland, which has been compared to the tongue of a dog, is placed across the spine behind the stomach, in the epigastric region. It extends into the left hypochondriac region, and it is placed before the aorta, vena cava, part of the splenic vessels, and in front of a part of the edge of the transverse part of the duodenum.

This gland has no proper capsule excepting at its fore part, and where it is covered by the root of the mesocolon; and the other parts of this gland are connected to the neighbouring parts by loose cellular substance, which behind connects it to the vertebræ.

The pancreas is about seven inches in length, and two in breadth, and its right or larger extremity is connected by short cellular substances to the left side of the second turn of the duodenum, from which part of it there is a process called the *lesser pancreas*, which also is fixed to the duodenum: and the left or smaller extremity is fixed to the spleen by the omentum majus.

There is some little variety as to the shape of this gland. The anterior and posterior surfaces of this gland are nearly flat. There is a sort of groove in this gland, in which the splenic artery is placed.

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* See the opinion of Mr HEWSON on the Use of the Spleen, in his Essay on the Blood.—Vide also the Observations of my Father on the Use of the Spleen, in his book on the Anatomy of Fishes.

The larger lobes of the pancreas are composed of smaller lobules, from each of which there is a *small duct*; and these smaller ducts unite and *form the larger pancreatic duct*, which begins from the left extremity of the pancreas; and from the addition of the smaller lateral branches it becomes gradually larger; and at the right extremity of the pancreas the duct of the smaller pancreas joins the larger pancreatic duct. The duct of the pancreas has thin coats, and is very readily torn. The larger duct runs from the one end of the gland to the other, becoming gradually larger towards the right end. It is of a white colour, and its coats are then by no means so thick and dense as those of the parotid gland.

The larger duct generally enters the duodenum along with, or near to, the ductus communis choledochus, at the lower and posterior part of the second curvature of that bowel; but in some cases the duct opens separately into the duodenum.

De Graaf, a great many years ago, by fixing a tube into the duct of this gland in dogs, discovered that the liquor secreted by it was in all respects similar to spittle.

The pancreas receives many small ramifications of the mesenteric and splenic arteries. The veins join with the superior mesenteric veins, and assist in forming the vena portæ. The nerves of the pancreas creep along the arteries, and are derived from the cæliac plexus.

The absorbent vessels of the pancreas unite with the plexus of the absorbents from the spleen, and terminate in the thoracic duct.

SECTION VI.

OF THE OMENTA.

The Omenta are composed of follicles, containing fat, connected to each other by cellular substance, and covered by the peritonæum. The smaller is placed between the liver, and smaller curvature of the stomach; and the larger depends from the spleen, the stomach, and colon, and in part covers the smaller intestines.

The peritonæum passes off double from the concave part of the liver to the upper part, or lesser curvature, of the stomach, forming what has been called the *omentum minus*, or *omentum hepato-gastricum*. This is bounded on the right side by the large vessels which carry the blood into the liver, and which are said to be enclosed in the capsule of GLISSON; and on the left side by the œsophagus and upper orifice of the stomach.

The two layers of the omentum minus separate from each other when they reach the stomach, and give an external coat to that organ; then reunite; and, by their continuation, form the anterior part of the *greater omentum*.

The greater omentum hangs down from the greater curvature of the stomach, and is fixed to the colon, and therefore called *omentum majus gastro-colicum:* And as a portion of the omentum majus extends farther to the right side than the stomach, following the colon, that portion of it has been called *omentum colicum dextrum*.

The layers of the great omentum separate from each other, and include the colon; hence that part of the omentum which hangs from the stomach and colon is quadruple.

The layers of the *omentum minus* separate from each other, on its right side, to inclose the vena portæ, hepatic artery, biliary ducts and the nerves of the liver, or to form what has been called the *capsule of* GLISSON: and hence, behind these vessels, *a hole large enough to admit a finger readily is formed*, which was first described by WINSLOW, and has been called *the foramen of* WINSLOW.

When the finger, therefore, is introduced into this hole, it passes behind the omentum hepato-gastricum; and if, next, the finger be turned downwards, it passes downwards behind the stomach, and then behind the fore part of the great omentum; and then downwards behind it, to the upper part of the colon and mesocolon.

This hole, therefore, leads to a great sac behind the lesser omentum, then behind the stomach and omentum gastro-colicum; and the colon and mesocolon form the bottom of the sac; and at the back part of it the pancreas is placed.

In a child this sac may be inflated from the foramen.

In the human subject, the omentum majus, on some occasions, extends as far down as the navel; but in quadrupeds, whose hind legs are longer than their fore, it descends to the bottom of the belly; which renders it probable that a liquor, which lubricates and prevents the concretion of the bowels, is derived from the omentum; though the ducts through which it flows are not visible.

This organ varies in its bulk.

In the corpulent, it sometimes acquires a considerable thickness; but in the emaciated, the greater part of its fat is abstracted, and it assumes a reticulated appearance.

The under portion of this organ is loose, and readily changes its situation: hence, when the intestines are protruded, it frequently forms a part of the contents of a hernial sac.

We are as yet totally ignorant of the use of the omenta.

END OF VOL. I.

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